TM 11-6625-345-45

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

GS AND DEPOT MAINTENANCE MANUAL

CALIBRATOR SET, FREQUENCY AN/URM-18A

ABMTSRV

HEADQUARTERS, DEPARTMENT OF THE ARMY
1 DECEMBER 1966

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the 425–volt modulator power supply and modulator circuits, or on the 115-volt ac line connections. Serious injury or death may result from contact with these points.

DON'T TAKE CHANCES!

EXTREMELY DANGEROUS VOLTAGES

EXIST IN THE FOLLOWING UNIT:

Oscilloscope OS–16A/URM–18	1,500-volt circuits

RADIATION HAZARD

Tube type 5651 used in this equipment contains radioactive material. These tubes are potentially hazardous when broken; see qualified medical personnel and the Safety Director if you are exposed to or cut by broken tubes. Use extreme care in replacing these tubes (para 62, TM 11–6625–345–12) and follow safe procedures in their handling, storage, and disposal (para 66, TM 11–6625–345–12).

Never place radioactive tubes in your pocket.
Use extreme care not to break radioactive tubes while handling them.
Never remove radioactive tubes from cartons until ready to use them.
Refer to paragraph 66, TM 11–6625–345–12, on handling, storage, and disposal of radioactive material.

CAUTION

Do not make resistance measurements on the transistorized circuits of the units listed below. (See paragraphs 2–2 and 3–1 before making resistance measurements in these components.)

Panel, Control SB–105A/URM–18
Frequency Divider CV–1517/URM–18A
Standard Frequency Oscillator O–1106/URM–18A

TECHNICAL MANUAL
No. 11–6625–345–45

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WASHINGTON, D. C. 20315, *1 December 1966*

CALIBRATOR SET, FREQUENCY AN/URM–18A

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***This manual supersedes TM 11–6625–345–45 dated 29 September 1964.**

CHAPTER 1

FUNCTIONING OF EQUIPMENT

Section I. GENERAL

1–1. Scope

a. This manual contains general support and depot maintenance instructions for Calibrator Set, Frequency AN/URM–18A. It includes instructions appropriate to general support and depot for troubleshooting, testing, aligning, repairing the equipment, and repairing specified maintenance parts. It also list tools, materials, and test equipment for general support and depot maintenance. Detailed functional analysis for the equipment is covered in this chapter.

b. The complete technical manual for this equipment includes four other publications: TM 11–6625–345–12, TM 11–6625–345–10P, TM 11–6625–345–20P, and TM 11–6625–345–35P.

c. Report of errors, omissions, and recommendations for improving this manual by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to DA Publications) and forwarded direct to Commanding General, U. S. Army Electronics Command, ATTN: AMSEL-MR-NMP-AD, Fort Monmouth, New Jersey 07703.

Note. For applicable forms and records, see paragraph 3, TM 11–6625–345–12.

1–2. Index of Equipment Publications

Refer to the latest issue of DA Pam 310–4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment. Department of the Army Pamphlet No. 310–4 is a current index of technical manuals, technical bulletins, supply manuals (types 7, 8, and 9), supply bulletins, and lubrication orders, and modification work orders available through publications supply channels. The index lists the individual parts (–10, –20, –35, etc) and the latest changes and revisions of each equipment publication.

1–3. Fundamental Principles of Frequency Measurement

a. The determination of frequency directly in terms of time is a fundamental measurement, since frequency is the time rate of recurrence of a cyclical phenomenon. A primary standard of frequency is one with its frequency determined directly in terms of time. A secondary standard is one with its frequency determined by a comparison with a primary standard, or by comparison with another secondary standard which was originally compared with a primary standard. Calibrator Set, Frequency AN/URM–18A employs a secondary standard when Clock TD–26/U is not used.

b. The classifications of frequency standards in *a* above have nothing to do with the accuracies of the standards. The same standard is logically classed as a primary standard if checked directly against time signals with Clock TD–26/U and as a secondary standard when checked against standard frequency transmissions (representing a distant primary standard).

c. In practice, the responsibility of establishing and maintaining accurate time determinations by astronomical observations is not assumed by the individual desiring a primary standard of frequency. The time determinations are carried out by observatories especially equipped for the purpose. The results are made available to a large number of users by radio and wire transmission. In the United States, the U. S. Naval Observatory transmits high-precision time signals by radio through the facilities of the U. S. Naval Radio Service. Transmissions on several frequencies are available several times a day and can be received nearly all over the world.

d. The user of a primary frequency standard

can then conveniently determine the frequency of the standard in terms of the standard time interval sent to him by radio. For the most precise results, the errors of the transmitted time signal must be taken into account. Correction data may be obtained by applying to the Superintendent, U.S. Naval Observatory, Washington, D. C.

e. The astronomical clocks now used at the U.S. Naval Observatory are piezoelectric oscillators and are similar to those used in accurate frequency standards. Through the close cooperation of the U.S. Naval Observatory and the National Bureau of Standards, the piezoelectric oscillators of the latter's primary frequency standard are checked in the same way as the former's astronomical clocks; the comparison with time is carried out by the observatory. The standard frequency transmissions, sent out by the National Bureau of Standards, represent a primary standard of high precision available to all who can receive the transmissions. Where such transmissions can be received, it is generally more convenient and much quicker to make the comparison by frequency than by time. For information and schedules of transmission of standard frequency, apply to the Radio Divison, Bureau of Standards, Department of Commerce, Washington, D.C. Because of the vagaries of high-frequency (hf) transmission, many users rely on checks against time as a reserve. They also use the primary standard as a high-precision clock for laboratory timing purposes.

f. As so far considered, the frequency calibrator is a single-frequency device. For practical utility, it is necessary to obtain from this single frequency many other frequencies, both above and below the standard frequency, for convenience in measurements. Since the frequency calibrator generates a standard frequency signal of 5 megacyles (mc), it is necessary to divide the frequency to obtain a value that an easily constructed synchronous motor can be used to count the number of cycles executed by the frequency calibrator in a standard interval of time. This operation is performed by the frequency divider. For measurements of high radiofrequencies, it is necessary to multiply the standard frequency to obtain useful frequencies in the range of the frequency being measured. This operation is performed by the frequency multiplier.

g. The frequency divider and frequency multiplier are characterized by their susceptibility to control by an introduced voltage, the frequency of which is the frequency of the frequency calibrator. In the controlled conditions, the frequency of the frequency divider and frequency multiplier bears an integral relationship to the frequency of the controlling voltage.

1–4. Overall Functional Block Diagram (fig. 1–1)

a. Calibrator Set, Frequency AN/URM–18A consists of a secondary frequency standard of three units (Standard Frequency Oscillator O–1106/URM–18A, Frequency Multiplier CV–1518/URM–18A and Frequency Divider CV–1517/URM–18A), five measuring units, and Panel, Control SB–105A/URM–18. Signal paths and the units are shown in figure 1–1 and are discussed in (1) through (4) below.

(1) Standard Frequency Oscillator O–1106/URM–18A applies 5 mc to Frequency Multiplier CV–1518/URM–18A and Frequency Divider CV–1517/URM–18A.

(2) Frequency Multiplier CV–1518/URM–18A provides 10 mc and 100 mc standard frequency outputs.

(3) Frequency Divider CV–1517/URM–18A provides standard frequency sine-wave outputs of 1 kilocycle (kc) and 100 kc and applies standard frequency 10 kc, 1 kc, and 0.1 kc sine-wave outputs to Oscilloscope OS–16A/URM–18 and standard frequency 100-kc and 10-kc square-wave outputs to Panel, Control SB–105A/URM–18.

(4) The remaining signal paths are through Panel, Control SB–105A/URM–18. The unknown frequency to be measured is applied to the control panel, which routes this signal along with harmonics of the 100-kc and 10-kc standard frequencies to the detector inputs of Frequency Meters FR–43A/URM–18, FR–44/URM–18, and FR–45A/URM–18 and Loudspeaker, Magnetic LS–205/U. The outputs of the frequency meter sections of Frequency Meters FR–

43A/URM–18, FR–44/URM–18, and FR–45A/URM–18 are also applied, through the control panel, to the inputs of the detector sections of the frequency meters. The detector section outputs are applied, through the control panel, to Oscilloscope OS–16A/URM–18, Generator, Signal SG–42/URM–18, and Loudspeaker, Magnetic LS–205/U. The control panel provides external outputs for the frequency meter sections of Frequency Meters FR–43A/URM–18, FR–44/URM–18, and FR–45A/URM–18. The signal generator output is applied, through the control panel, to the loudspeaker.

b. The range of standard secondary frequencies, obtained from Standard Frequency Oscillator O–1106/URM–18A, Frequency Divider CV–1517/URM–18A, and Frequency Multiplier CV–1518/URM–18A functioning together as a source of standard frequencies, is shown in figure 1–2. In the audiofrequency (af) and low radiofrequency range, a cathode-ray oscilloscope is used to compare known frequencies. This is simpler than trying to make use of harmonics of the low standard frequencies.

1–5. Functioning of Frequency Measurements

a. After establishing a series of standard frequencies covering a portion of the frequency spectrum in which measurements are to be made, compare any unknown frequency with one of the standard frequencies. When an unknown frequency lies between two of the standard frequency harmonics (fig. 1–3), to determine the difference in frequency between the unknown frequency and the nearest of the standard frequencies. This difference is added to the standard frequency if the unknown frequency lies above the standard; it is subtracted if the unknown frequency lies below the standard.

b. For evaluating a frequency difference (A or B, fig. 1–3), beat a standard frequency and an unknown frequency in a detector and measure the beat frequency, by comparison, with a calibrated audio oscillator. Figure 1–4 shows this direct-beating method of frequency measurement.

c. In the block diagram (fig. 1–1), standard frequencies are introduced into the frequency-measuring units through Panel, Control SB–105A/URM–18 and are compared by the selected units with the unknown frequency to be measured. The measuring units used at any one time will depend on the frequency range of the unknown frequency being measured.

(1) Unknown audiofrequencies from 0 to 5 kc are quickly measured (fig. 1–5) by matching them directly with Generator, Signal SG–42/URM–18, using the direct FREQUENCY scale. The signal generator frequency can be varied to equal the frequency being measured as shown on the OUTPUT meter of the signal generator (used as a beat indicator) or on Oscilloscope OS–16A/URM–18. For very low frequencies, Oscilloscope OS–16A/URM–18 is most useful, since it permits Generator, Signal SG–42/URM–18 to be set accurately to a multiple of the frequency being measured. The type pattern obtained on the oscilloscope indicates the multiple used.

(2) In the range of 5 to 100 kc, two methods are available. The first method (fig. 1–5) uses Oscilloscope OS–16A/URM–18 with a variable-frequency circular sweep produced by Generator, Signal SG–42/URM–18. The frequency to be measured is connected to the radial deflection amplifier of the oscilloscope. With Generator, Signal SG–42/URM–18 at 5 kc on the direct FREQUENCY scale, the signal generator frequency is gradually reduced until a single line pattern is obtained. The number of scallops around the pattern gives the number of times the signal generator frequency is contained in the unknown frequency or the number of times the signal generator frequency must be multiplied to obtain the unknown frequency. The signal generator calibration can be standardized against

the standard frequency, and readings of the signal generator frequency can be made to within ±0.1 cycle, giving the results within 1 or 2 cycles for frequencies up to 100 kc.

(3) In the second method (fig. 1–6), harmonics of the frequency being measured are used so that a signal can be obtained at a frequency over 100 kc, the lower limit of Frequency Meter FR–43A/URM–18. The procedure followed is the same as outlined in *d* below. If the source has no harmonics, they can be generated by passing the source output through a rectifier or distorting amplifier. For harmonics which fall just above 100 kc, the frequencies can be measured to within ±0.1 cycle.

(4) Frequencies throughout the 100-kc to 10-mc range are measured in terms of 10-kc harmonics from the standard frequency (fig. 1–7). Frequencies below this range may be brought into the range by harmonic multiplication (*b* and *c*(1) through (3) above). Frequencies above this range may be brought into the range by harmonic division ((5) below). Measurements can be made within an accuracy of ±0.1 cycle. Any unknown frequency in this range lies between two adjacent 10-kc harmonics of the standard frequency, and will not be over 5,000 cycles away from one of them. The difference in frequency between unknown frequency and the nearest standard frequency is obtained by beating in the detector section of a frequency meter. This frequency difference is then measured by matching it with Generator, Signal SG–42/URM–18.

(5) For unknown frequencies above 10 mc, it is not practical to use 10-kc standard harmonic frequencies for making measurements (fig. 1–7). Difficulties are encountered in producing such high order harmonics of usable signal strength and also in identifying them. An alternative is to divide the unknown frequency by a known number to bring the resultant into the range of frequencies from 100 kc to 10 mc. One method is to use a highly stable, accurately calibrated oscillator (heterodyne-frequency meter) as a divider. A harmonic of the oscillator is accurately matched to the frequency being measured. The fundamental frequency of the oscillator is then measured by beating against the standard frequency harmonic. The unknown frequency is then the measured value of the oscillator fundamental frequency multiplied by the harmonic number of the oscillator that was used to match the unknown.

d. Calibrator Set, Frequency AN/URM–18A is not designed for directly measuring frequencies above 100 kc but, with additional external frequency meters, it can be used to measure frequencies up to 1,000 mc.

Section II. FUNCTIONING OF STANDARD FREQUENCY OSCILLATOR O–1106/URM–18A

1–6. Standard Frequency Oscillator O–1106/URM–18A Block Diagram (fig. 1–8)

Standard Frequency Oscillator O–1106/URM–18A (frequency calibrator) provides a 5-mc standard frequency output to Frequency Multiplier CV–1518/URM–18A and Frequency Divider CV–1517/URM–18A. The 5 mc output may also be applied to Panel, Control SB–105A/URM–18 to be used in the performance of frequency-measuring operations. Signal paths and major functional sections of the unit are shown in the block diagram and are discussed in *a* through *i* below. For complete circuit details, refer to the overall schematic diagram (fig. 4–4 ① and ②).

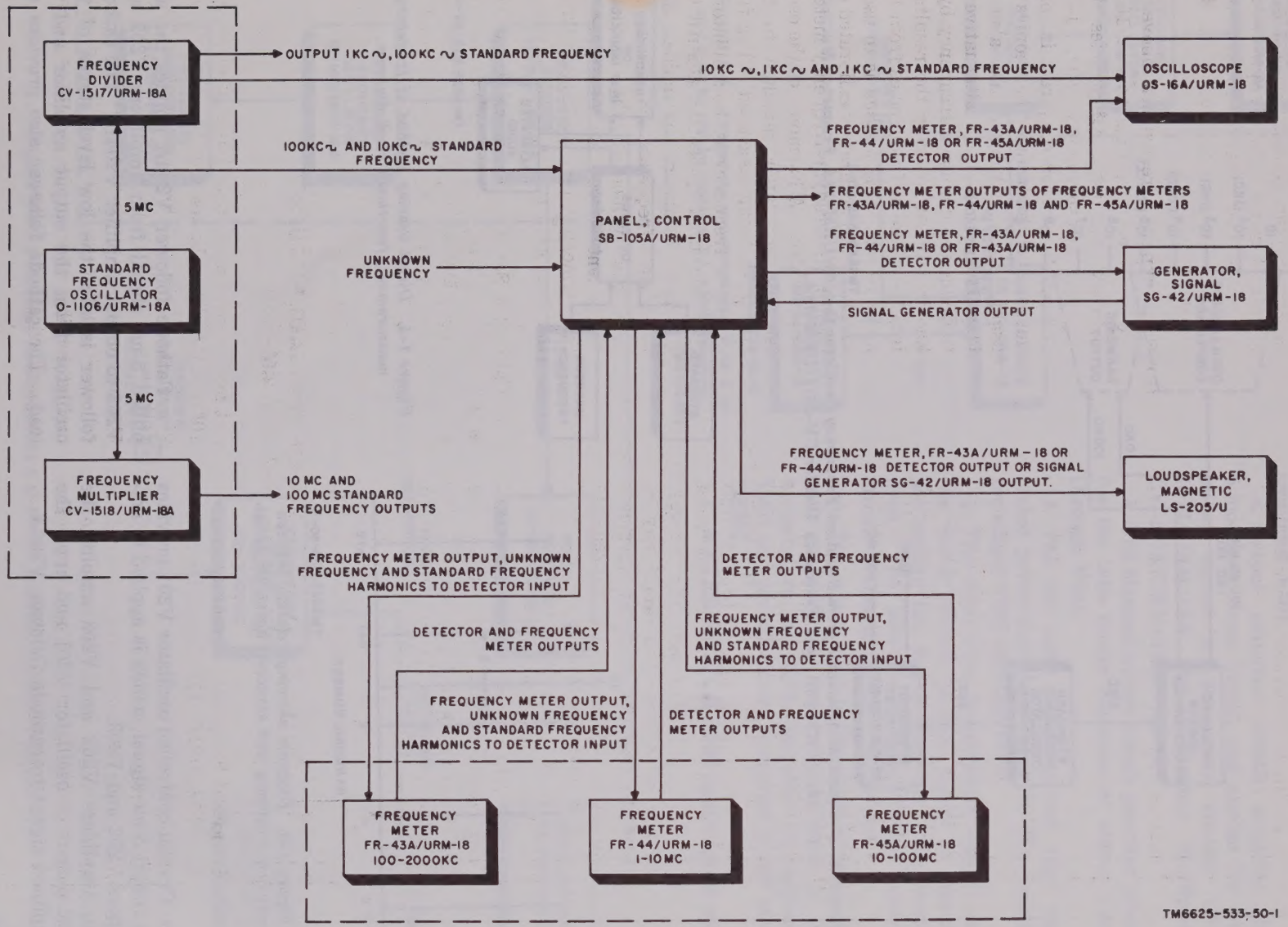

FREQUENCY DIVIDER CV-1517/URM-18A
OUTPUT 1KC ~, 100KC ~ STANDARD FREQUENCY
10KC ~, 1KC ~ AND .1KC ~ STANDARD FREQUENCY
OSCILLOSCOPE OS-16A/URM-18
100KC~ AND 10KC~ STANDARD FREQUENCY
FREQUENCY METER, FR-43A/URM-18, FR-44/URM-18 OR FR-45A/URM-18 DETECTOR OUTPUT
FREQUENCY METER OUTPUTS OF FREQUENCY METERS FR-43A/URM-18, FR-44/URM-18 AND FR-45A/URM-18
5MC
PANEL, CONTROL SB-105A/URM-18
STANDARD FREQUENCY OSCILLATOR O-1106/URM-18A
UNKNOWN FREQUENCY
FREQUENCY METER, FR-43A/URM-18, FR-44/URM-18 OR FR-43A/URM-18 DETECTOR OUTPUT
GENERATOR, SIGNAL SG-42/URM-18
SIGNAL GENERATOR OUTPUT
5MC
FREQUENCY METER, FR-43A/URM-18 OR FR-44/URM-18 DETECTOR OUTPUT OR SIGNAL GENERATOR SG-42/URM-18 OUTPUT.
LOUDSPEAKER, MAGNETIC LS-205/U
FREQUENCY MULTIPLIER CV-1518/URM-18A
10 MC AND 100 MC STANDARD FREQUENCY OUTPUTS
FREQUENCY METER OUTPUT, UNKNOWN FREQUENCY AND STANDARD FREQUENCY HARMONICS TO DETECTOR INPUT
DETECTOR AND FREQUENCY METER OUTPUTS
DETECTOR AND FREQUENCY METER OUTPUTS
FREQUENCY METER OUTPUT, UNKNOWN FREQUENCY AND STANDARD FREQUENCY HARMONICS TO DETECTOR INPUT
FREQUENCY METER OUTPUT, UNKNOWN FREQUENCY AND STANDARD FREQUENCY HARMONICS TO DETECTOR INPUT
DETECTOR AND FREQUENCY METER OUTPUTS
FREQUENCY METER FR-43A/URM-18 100-2000KC
FREQUENCY METER FR-44/URM-18 1-10MC
FREQUENCY METER FR-45A/URM-18 10-100MC
TM6625-533-50-1

Figure 1–1. Calibrator Set, Frequency AN/URM–18A, block diagram.

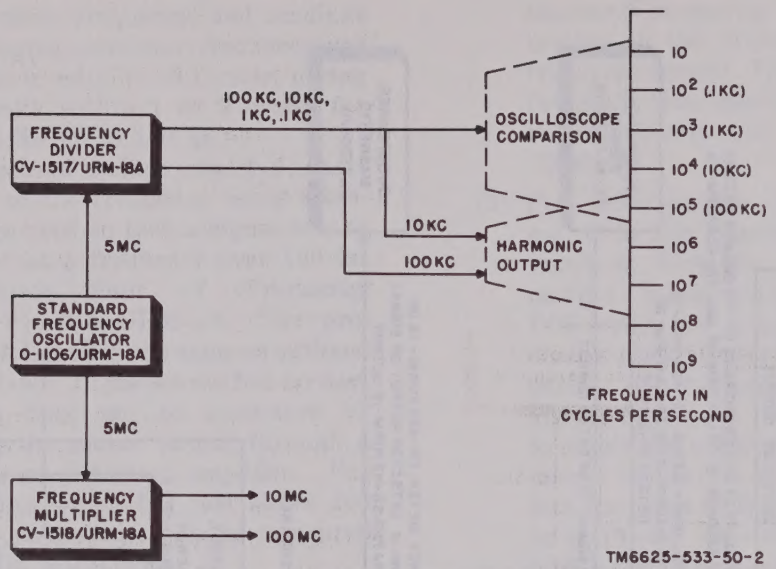


Figure 1–2. Frequencies obtainable from Standard Frequency Oscillator O–1106/URM–18A, Frequency Multiplier CV–1518/URM–18A, and Frequency Divider CV–1517/URM–18A.

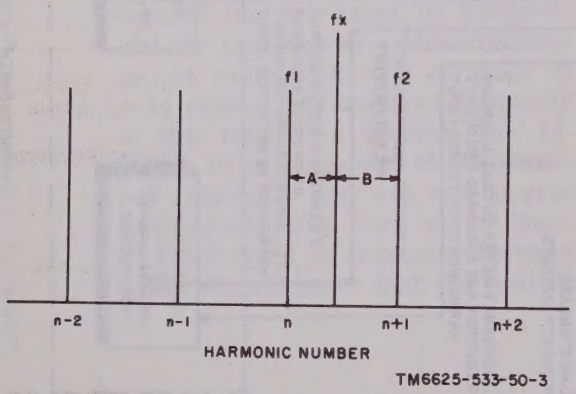


Figure 1–3. Diagram showing relation between unknown frequency and standard harmonic series.

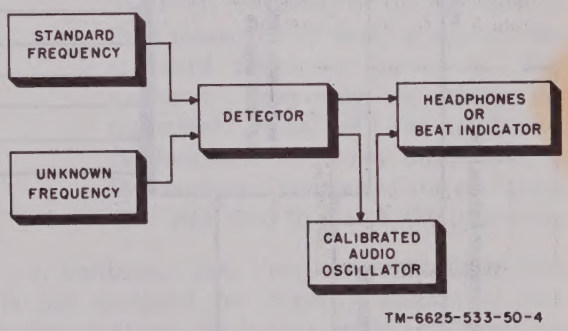


Figure 1–4. Direct beating method of frequency measurement, functional block diagram.

a. Crystal-controlled oscillator V201 provides the initial 5-mc signal, which is applied to amplifiers V202 and V203.

b. Amplifiers V202 and V203 amplify the 5-mc output of oscillator V201 and apply the amplified signal to cathode follower V204A.

c. Cathode follower V204A applies the amplified 5-mc signal from amplifiers V202 and V203 to output amplifier V204B. The cathode follower isolates the low level stages of the oscillator from the output amplifier and its load. The cathode follower also provides de-

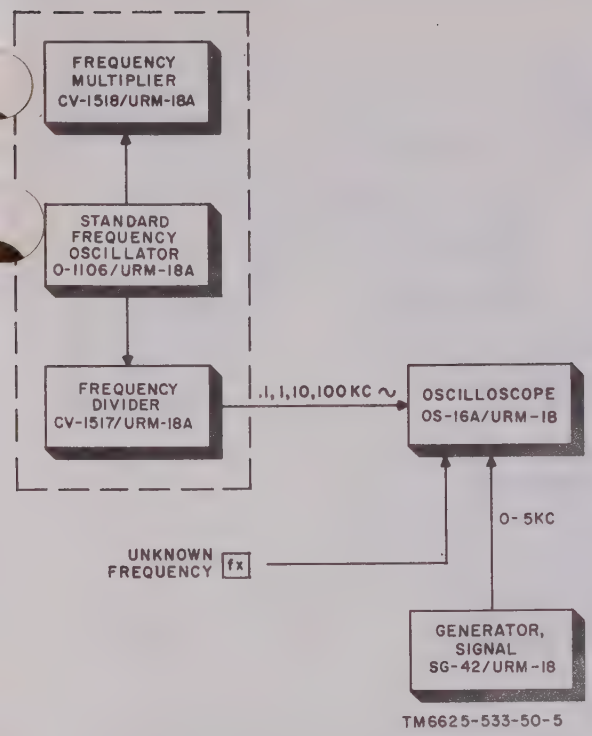


Figure 1–5. Frequency measurements, 0 to 5 kc and 5 kc to 100 kc (method 1), block diagram.

generative feedback for amplifier V202 and automatic gain control (agc) voltage for oscillator V201.

d. Output amplifier V204B amplifies the 5-mc signal from V204A and applies the amplified signal to Frequency Divider CV–1517/URM–18A and Frequency Multiplier CV–1518/URM–18A.

e. The filament power supply provides power for the tube heater filaments of stages V201 through V204.

f. The 200 volts direct current (dc) regulated power supply provides the B+ voltage for stages V201 through V204.

g. The outer oven temperature control and fan motor circuits provide power to operate the cooling fan and to heat the outer crystal oven. The outer oven temperature control circuit is thermostatically controlled.

h. The inner oven temperature control circuits maintain the inner crystal oven at the temperature for stable operation of oscillator V201 and provide power to operate power lamp DS201.

i. METER SWITCH S503 applies plate cur-

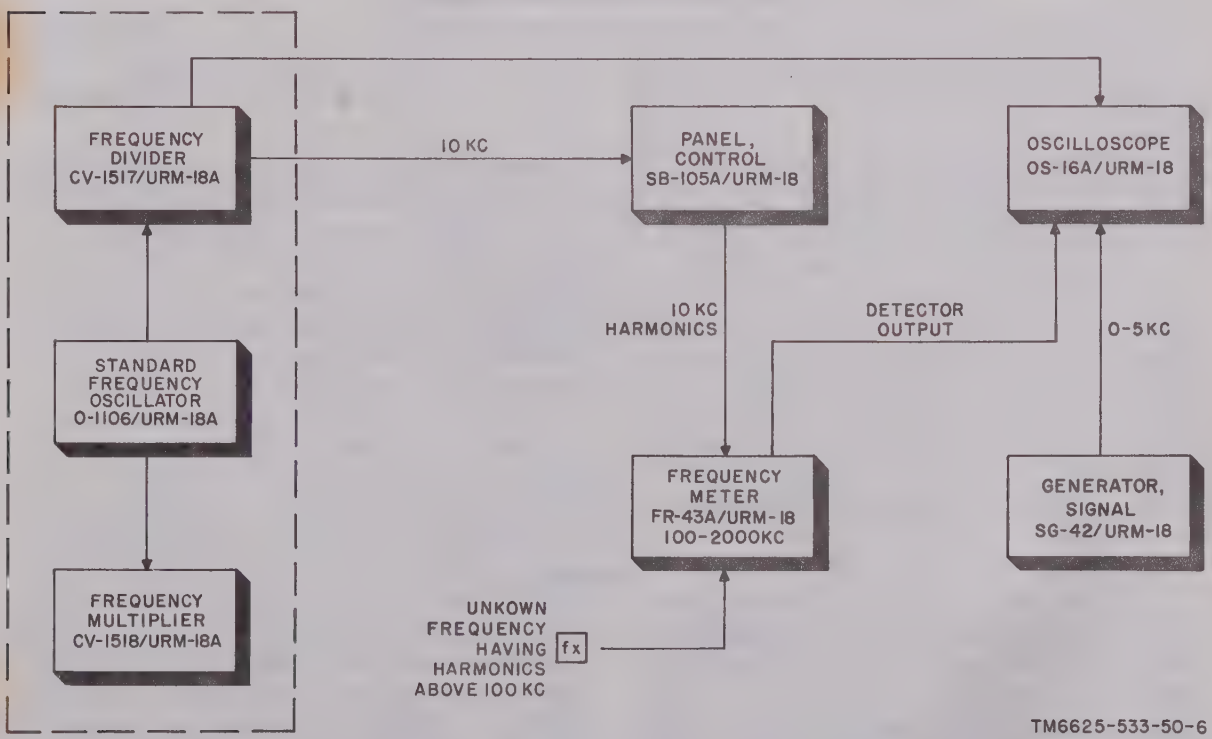


Figure 1–6. Frequency measurements 5 to 100 kc (method 2), block diagram.

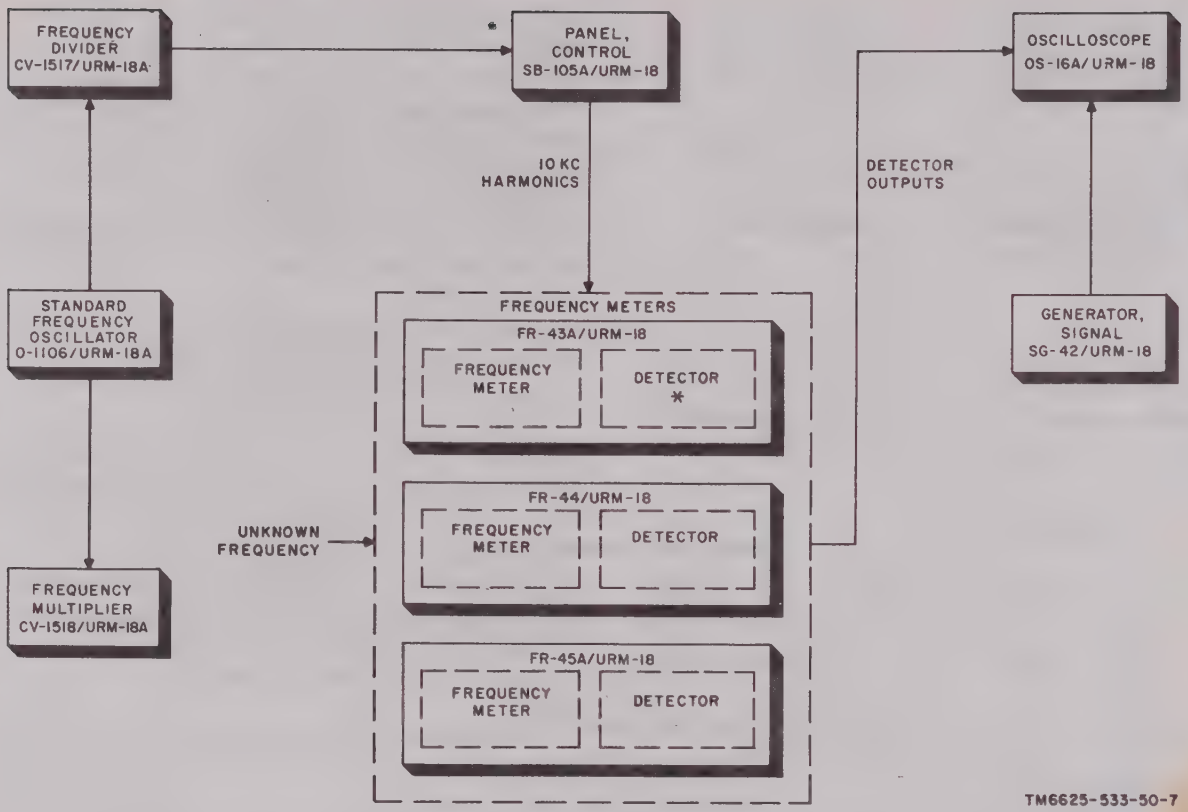


Figure 1–7. Frequency measurements 100 kc to 10 mc and 10 mc to 100 mc, block diagram.

rent from the oscillator V201, agc voltage from cathode follower V204A, negative voltage from the output of output amplifier V204B, and from the filament power supply rectifier to meter M501. Filament power supply input supplies current for the oven sensing elements. Meter M501 indicates agc voltage level, frequency calibrator output level, oscillator plate voltage drop (as a measure of oscillator operation), and inner and outer oven temperatures.

1–7. Oscillator V201 (O–1106/URM–18A)

(fig. 1–9)

Oscillator V201 is a 5-mc modified Pierce oscillator employing 1 mc crystal Y601 operated in the fifth overtone mode. Regenerative feedback is applied to the cathode of V201 through inductance-capacitance (Lc) circuit C604, L602 instead of through the interelectrode capacitance of the tube. This circuit is capacitive for a 5-mc signal and thus can provide positive feedback at that frequency. Since it is inductive below 3.7 mc, there is no regenerative feedback below that frequency. The circuit therefore cannot oscillate in the third overtone mode of the crystal. (Since the oscillator is tuned to an odd harmonic of the crystal, even harmonics are canceled.) Inductor L601 is used for initial frequency adjustment. Its value must be determined for each crystal unit. Capacitor C602 is the FREQ. COARSE control. Capacitor C246 is the FREQ. FINE control. Diode CR201 protects the crystal from transients during the start of oscillation. Capacitor C603 is a trimmer for C602. Capacitor C203 is a dc blocking capacitor that couples feedback from the V201 plate output to the grid circuit. Capacitor C605 is a frequency-compensation capacitor. Resistors R205 and R206 are parasitic suppressor resistors. Automatic gain control volt-

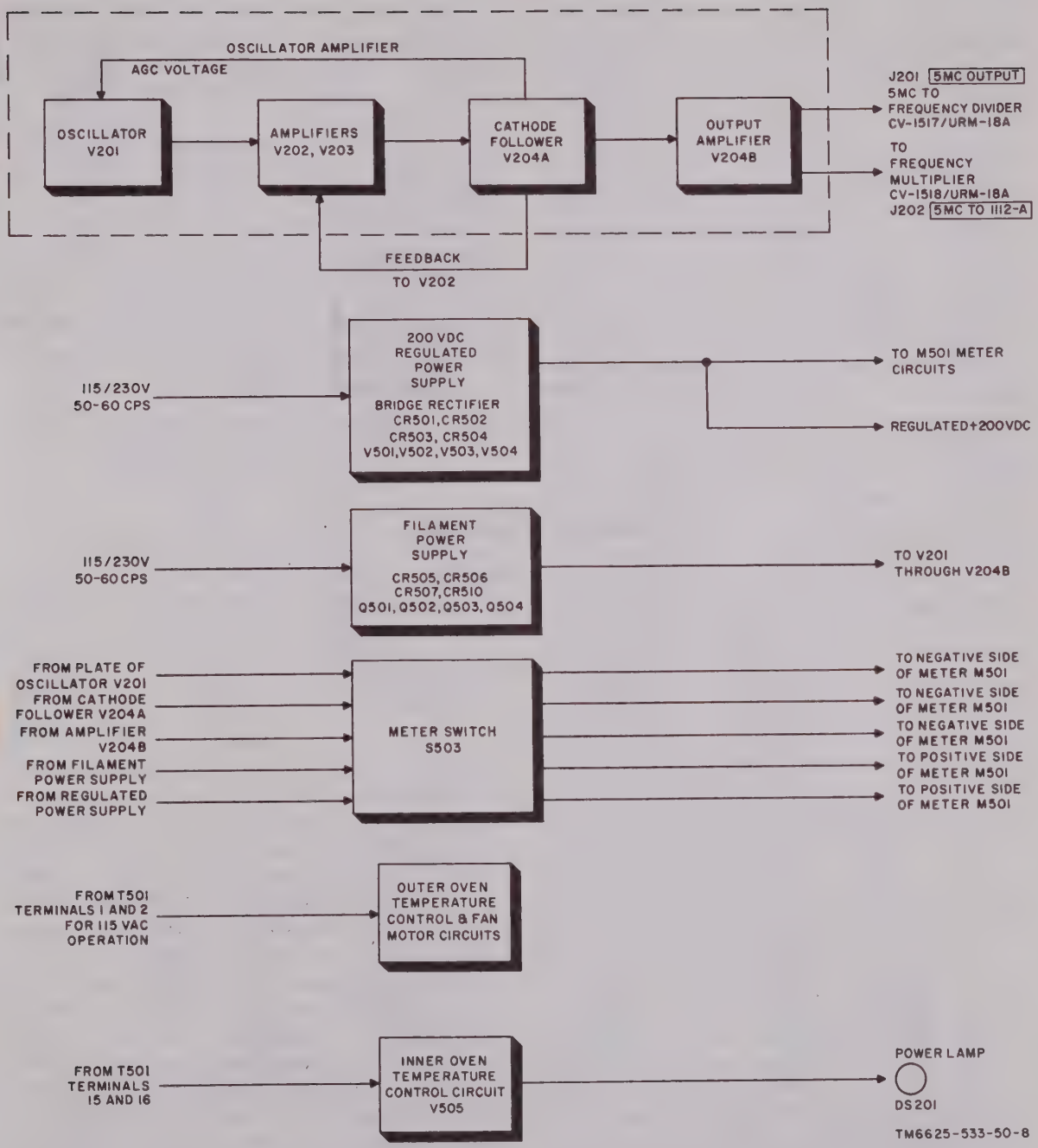

OSCILLATOR AMPLIFIER
AGC VOLTAGE
OSCILLATOR V201
AMPLIFIERS V202, V203
CATHODE FOLLOWER V204A
OUTPUT AMPLIFIER V204B
J201 5MC OUTPUT
5MC TO FREQUENCY DIVIDER CV-1517/URM-18A
TO FREQUENCY MULTIPLIER CV-1518/URM-18A
J202 5MC TO 1112-A
FEEDBACK TO V202
115/230V 50-60 CPS
200 VDC REGULATED POWER SUPPLY
BRIDGE RECTIFIER CR501, CR502 CR503, CR504 V501, V502, V503, V504
TO M501 METER CIRCUITS
REGULATED +200 VDC
115/230V 50-60 CPS
FILAMENT POWER SUPPLY
CR505, CR506 CR507, CR510 Q501, Q502, Q503, Q504
TO V201 THROUGH V204B
FROM PLATE OF OSCILLATOR V201
FROM CATHODE FOLLOWER V204A
FROM AMPLIFIER V204B
FROM FILAMENT POWER SUPPLY
FROM REGULATED POWER SUPPLY
METER SWITCH S503
TO NEGATIVE SIDE OF METER M501
TO NEGATIVE SIDE OF METER M501
TO NEGATIVE SIDE OF METER M501
TO POSITIVE SIDE OF METER M501
TO POSITIVE SIDE OF METER M501
FROM T501 TERMINALS 1 AND 2 FOR 115 VAC OPERATION
OUTER OVEN TEMPERATURE CONTROL & FAN MOTOR CIRCUITS
FROM T501 TERMINALS 15 AND 16
INNER OVEN TEMPERATURE CONTROL CIRCUIT V505
POWER LAMP
DS201
TM6625-533-50-8

Figure 1–8. Frequency Oscillator O–1106/URM–18A, block diagram.

age from cathode follower V204A is supplied to the grid. Resistor R208 and capacitors C207 and C206 filter out alternating current (ac) components of the agc voltage. Resistor R207 is the grid return. A voltage divider consisting of resistors R204 and R209 provides positive bias for the screen grid. Capacitor C208 is the screen bypass. Capacitor C204

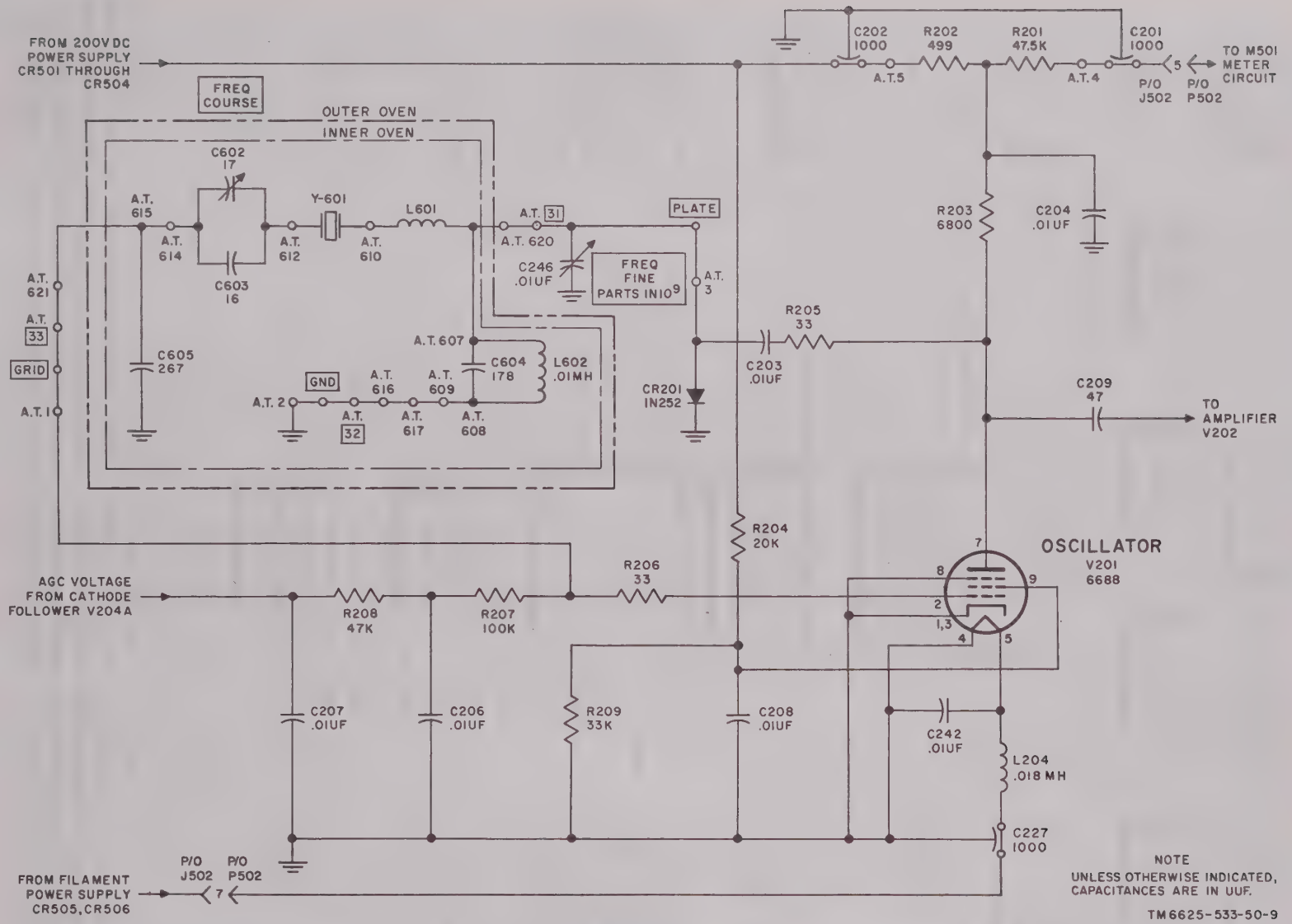


Figure 1–9. Oscillator V201 (O–1106/URM–18A), schematic diagram.

and resistor R202 make up the plate decoupling network. Resistor R203 is the plate-dropping resistor through which the B+ voltage is applied. The oscillator plate voltage is applied to meter M501 circuit through dropping resistor R201. Stray radiofrequency (rf) currents are bypassed to ground through feedthrough capacitors C201, C202, and C227. The 5-mc output is applied to amplifier V202 through coupling capacitor C209. A decoupling network consisting of inductor L204 and capacitor C242 keeps rf out of the filament power supply. For frequency stability, the crystal and associated components are enclosed in two concentric ovens that maintain a temperature of approximately 50° C (122° F).

1–8. Amplifiers V202 and V203 (O–1106/URM–18A)

(fig. 1–10)

a. General. Amplifiers V202 and V203 amplify the output of 5-mc oscillator V201 and apply the amplified signal to cathode follower V204A. Negative feedback from the cathode follower is applied to the input of amplifier V202. This rf feedback stabilizes the gain of the amplifiers. Capacitor C218 is a feedthrough capacitor that keeps rf out of the power supply.

b. Amplifier V202. The signal from oscillator V201 is applied to the control grid of amplifier V202 through parasitic-suppressor resistor R214. The signal is amplified by V202, appearing across the plate tank (tuned) circuit consisting of variable inductor L201 and capacitor C213. The tank circuit is tuned to 5-mc. Resistor R212 broadens the bandpass of the tank circuit. The output is applied to amplifier V203 through coupling capacitor C221. Fixed bias is provided for the grid of V202 by voltage dividers R226 and R228. Resistors R215, R216, and R228 comprise the dc control grid return for V202. Capacitor C216 is an rf bypass for fixed bias resistors R216 and R228. Resistor R217 and bypass capacitor C215 furnish fixed operating cathode bias for amplifier V202. Resistor R218 provides degenerative operating feedback bias. Capacitor C214 is a plate-decoupling capacitor, functioning in conjunction with plate voltage-dropping resistor R211 to keep rf out of the power supply. Resistor R213 is the screen grid voltage-dropping resistor. Capacitor C217 is the screen grid bypass. Inductor L205 and capacitor C243 comprise a decoupling network that keeps rf out of the filament power supply.

c. Amplifier V203. Amplifier V203 is similar to amplifier V202. The signal from amplifier V202 is applied to the control grid of V203 through capacitor C221 and parasitic-suppressor resistor R220. The signal is amplified by V203 and appears across the plate-tuned tank circuit (L202 and C220), which is tuned to 5-mc. The signal is then applied to V204A. The tuned tank circuit consists of variable inductor L202 and capacitor C220. Resistor R223 broadens the bandpass of the tuned tank circuit. Fixed bias at the control grid of V203 is provided from voltage divider R226 and R228. Resistors R221, R222, and R228 comprise the dc control grid return. Capacitor C224 is an rf bypass for resistors R222 and R228. Capacitor C225 keeps rf out of the power supply, bypasing it to ground. Cathode resistor R227, bypassed by capacitor C223, furnishes operating bias. Resistor R225 is the screen grid voltage-dropping resistor. Bypass capacitor C222, together with voltage-dropping resistor R224, decouples rf from the voltage supply. Capacitor C219 provides frequency compensation by means of degenerative feedback of unwanted frequencies. Inductor L206 and capacitor C244 comprise a decoupling network that keeps rf out of the filament power supply.

1–9. Cathode Follower V204A (O–1106/URM–18A)

(fig. 1–11)

Cathode follower V204A, primarily an isolating circuit, receives the 5 mc output signal of amplifier V203 and applies the output signal to output amplifier V204B. Part of this stage is an agc network which applies a dc voltage from the junction of R238 and C235 to control the gain of oscillator V201. The agc voltage is also applied to meter M501 circuit for measurement. Part of the output of V204A, from the junction of R235 and R236 is applied as degenerative feedback to the input of amplifier V202. The output of V203 is applied to the grid of V204A through coupling capacitor C229

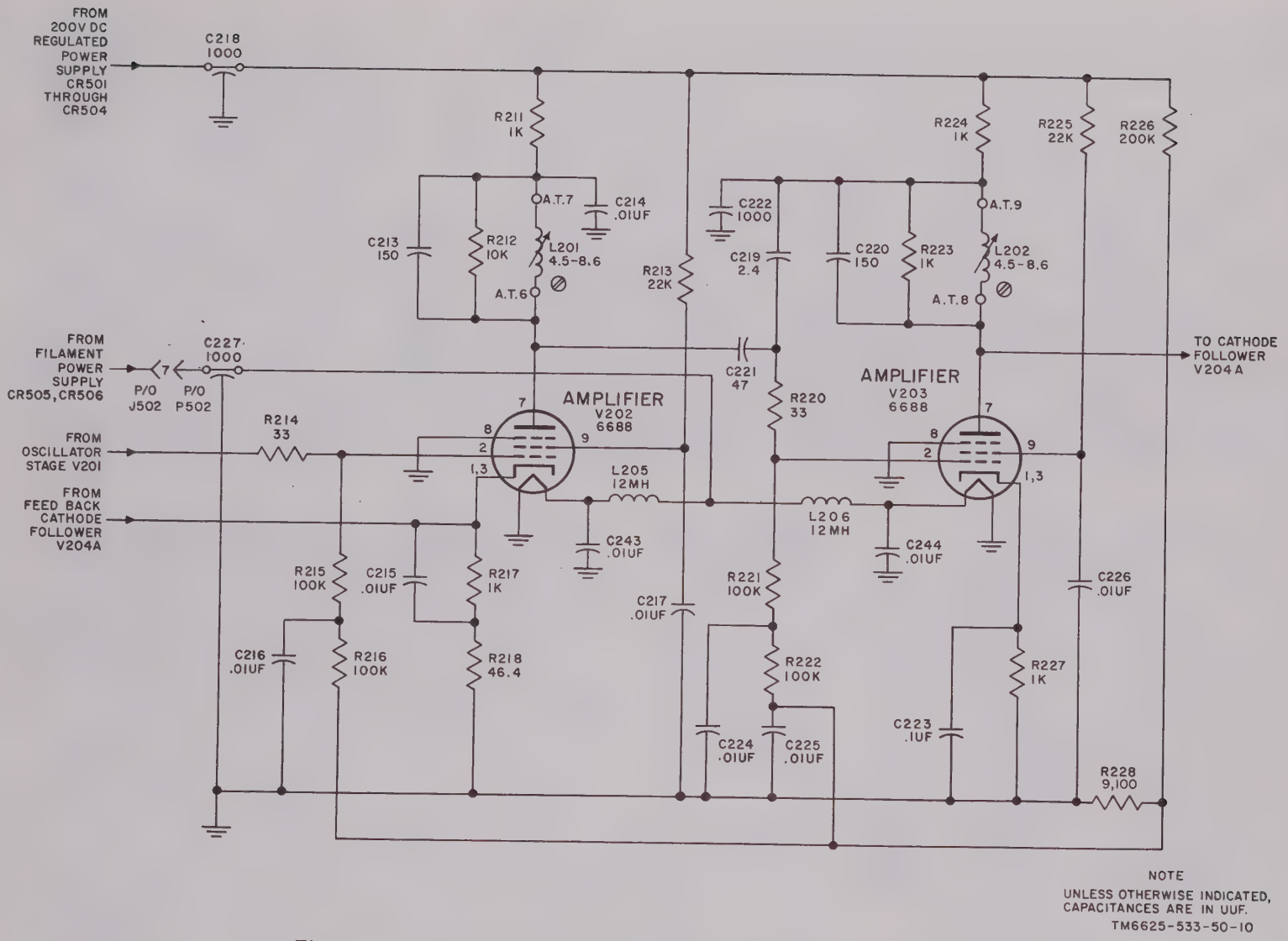


Figure 1–10. Amplifiers V202 and V203 (O–1106/URM–18A), schematic diagram.

and across control grid return resistor R234. The output to V204B is taken from across cathode resistors R235 and R236 and applied through coupling capacitor C233. Voltage divider R232 and R237 applies approximately 9 volts dc to the cathode of clamping diode CR202. Ac voltages above this value are shunted to ground through bypass capacitor C232. The portions of the output signal that are more negative than this voltage pass through blocking capacitor C231, rectifier CR203, and filter network C234, R238, and C235 and are applied as negative agc voltage to the grid of V201. The rectified negative voltage is also applied to the meter switch circuit through dropping resistor R239. Resistors R230 and R234 make up a voltage divider that applies fixed bias to the control grid of V204A. Resistor R231 is a plate voltage-dropping resistor. Capacitor C230 is a decoupling capacitor. Resistor R233 is a parasitic suppressor. Feedthrough capacitors C237 and C241 bypass high frequencies and prevent leakage at the entry points of their respective leads.

1–10. Output Amplifier V204B (O–1106/URM–18A)
(fig. 1–12)

a. Output amplifier V204B receives the output from the cathode follower V204A and applies the amplified signal to 5 MC OUTPUT jack J201, 5 MC to 1112-A jack J202, and meter M501 circuit.

b. The output of cathode follower V204A is applied to the control grid of V204B through coupling capacitor C233. The signal is amplified by V204B and appears in the tuned plate circuit, which is resonant at 5 mc. The tuned plate circuit is comprised of one winding of T201 and C239. The tuned plate signal is inductively coupled to the secondary of T201, which is a low-impedance winding. In turn,

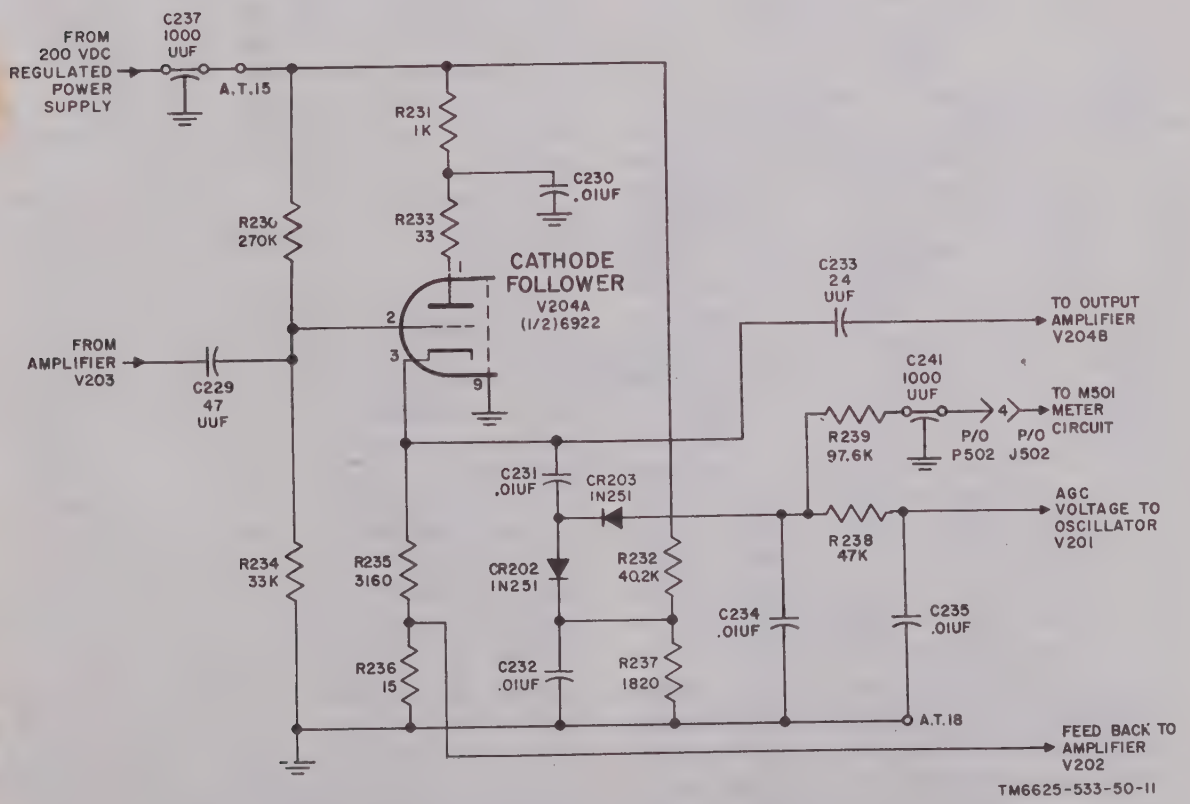


Figure 1–11. Cathode follower V204A (O–1106/URM–18A), schematic diagram.

the signal is then connected to J201. A portion of the output signal is applied to J202 through voltage-divider network R219 and R229. The output signal is also coupled through C240 and rectified by CR204 and applied to the meter circuit through R244. Resistor R240 is the control grid return resistor and R242 is the cathode-biasing resistor. Resistor R243, OUTPUT LEVEL, controls the gain of the stage. The input B+ circuit utilizes a decoupling network consisting of voltage-dropping resistor R241 and bypass capacitor C238. The filament circuit also contains a decoupling network consisting of L207 and C245.

1–11. B+ Power Supply (O–1106/URM–18A)

(fig. 1–13)

The B+ power supply consists of a bridge rectifier circuit, a series regulator, error-detecting, amplifying circuits, and a filter network. The primary of transformer T501 receives 115/230, 50 to 60 cycles per second (cps) ac through input jack J501, thermoswitch S501, and fuses F1 and F2. The fuses protect against excessive current. The thermoswitch protects against overheating of the transformer due to overload. Capacitors C506 and C507 bypass any high-frequency variations in the line voltage. During one half the cycle of input voltage to T501, diodes CR502 and CR503 conduct to permit the correct direction of current flow to the regulated power supply. During the alternate half of the cycle of input voltage, diodes CR501 and CR504 conduct to permit the same correct direction of current flow to the regulated power supply. As components are filtered by capacitors C501B and C501C. The rectified, filtered output current passes through series regulator V501 to the load. The amount of current conducted by V501 depends on its control grid to cathode bias. This bias, in turn is determined by the output of amplifier V502A. A voltage increase

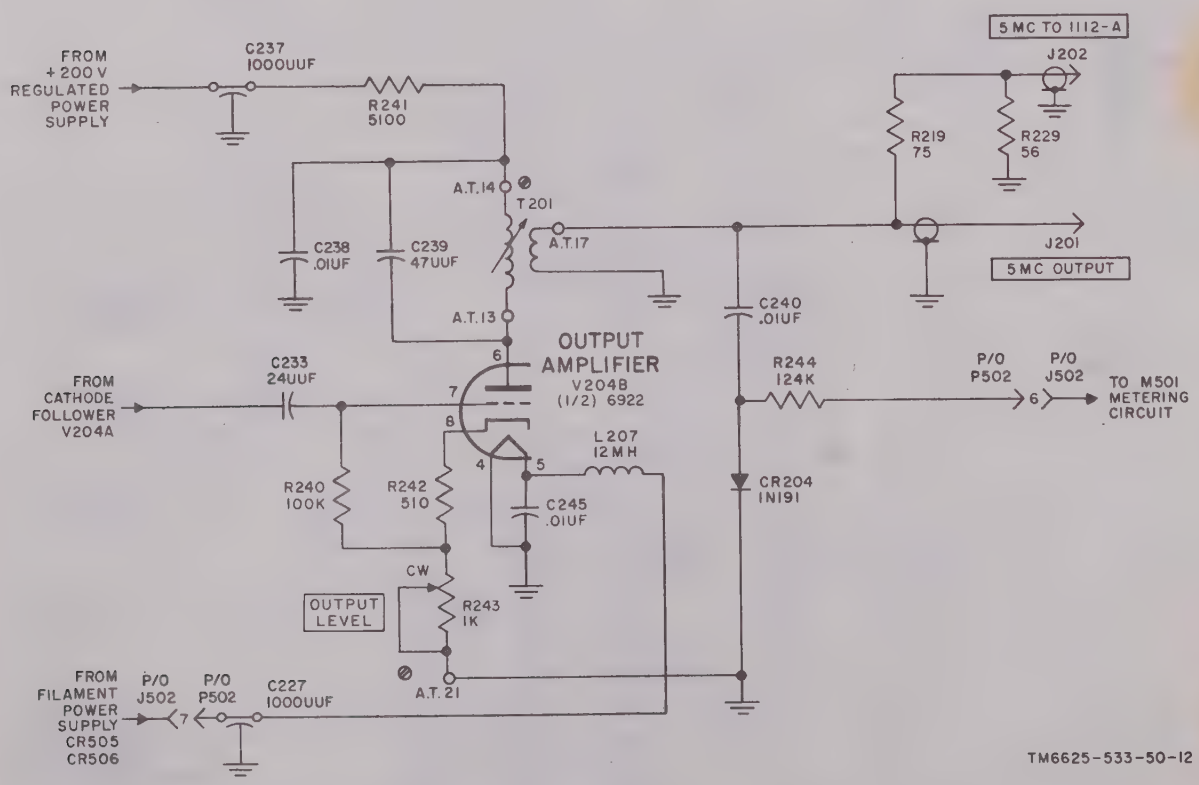


Figure 1–12. Output amplifier V204B (O–1106/URM–18A), schematic diagram.

in the output of the power supply due to a decrease in load or increase in line voltage results in a corresponding decrease in the output of V502A and an increase in the grid bias of the series regulator. The consequent rise in the internal impedance of the series-regulator tube limits the output with a resulting correction to the output voltage. If the output voltage of the power supply decreases due to an increase in load, then opposite conditions occur to result in V501 conducting more current to correct the output voltage. Resistor R501 is the screen voltage-dropping resistor and resistor R503 is the control grid return for V501. A portion of the output voltage, approximately +40 volts, taken from bleeder resistor network R515 and R522, is applied to the filament circuit of tubes V501 through V503. This action keeps the filaments positive with respect to their cathodes, thus preventing filament-to-cathode electron flow. Capacitor C501A is a filter capacitor for ac ripple and capacitor C505 is used to bypass any rf present across R522. A portion of the output voltage, selected from voltage divider R516 and R523, is applied to the control grid of differential voltage amplifier V503B through resistors R521 and R518. Rapid variations or surges are coupled from the output to the junction of R521 and R518 through capacitor C504. Voltage-regulator tube V504 maintains a constant voltage at the control grid of differential voltage amplifier V503A with respect to ground. Changes in the power supply output voltage, error voltages, are impressed on the grids of amplifiers V502B and V503B. The output of V503B and the input to V502B are summed up in the output of V502B. This is possible because the V502B cathode potential is determined by the output of V503B. The output of V502B, 180° out of phase with the corresponding power supply error voltage, is applied to the control grid of the series regulator by cathode follower output of V502A. Resistor R519 is the common cathode resistor for V503A and V503B. Resistors R509, R513, and R517 are the plate-dropping resistors for V503A, V502B, and V503B respectively. Resistor R517 also controls the screen-grid potential of V502B. Resistors R508 and R510 are current-limiting resistors. Resistors R511 and R507 make up the control grid return to ground for V503A. Resistors R504 and R506 are cathode resistors for V502A. A portion of the output across the cathode circuit of V502A is fed back to V503A through limiting resistor R505 and is used to stabilize the cathode potentials of V503A and V503B. Surges in the bridge rectifier output are coupled to amplifier V502B through coupling capacitor C502. This results in more rapid correction of large errors. The screen grid of V502B is connected directly to the cathode of V501. The positive 200 dc volts output of the regulated power supply is applied to oscillator amplifier stages V201 through V204 and to METER SWITCH S503. Ac power to the filaments of V501, V502, and V503 is supplied from transformer T501 secondary, terminals 11 and 12, through terminals 4 and 3 of switch S502. POWER switch S502 in the ON position applies ac power from secondary terminals 5 and 7 of transformer T501 to bridge rectifier CR501 through CR504 and to the filaments of stages V501 through V503.

1–12. Filament Power Supply (O–1106/URM–18A) (fig. 1–14)

The filament power supply consists of full-wave rectifiers CR505 and CR506, a series regulator, an error-detecting circuit, an amplifying circuit, and a filter network. During one half the cycle of input line voltage to T501, that portion of the secondary voltage across terminals 9 and 10 induces a current to flow outward through CR506. On the alternate half cycle, that portion of the secondary voltage across terminals 8 and 9 induces a current to flow outward through CR505. In both cases, the rectified output currents are in the same direction. This rectified output is applied in succession to input filter capacitors C510A and C510C, series regulator Q501 and its controlling elements Q502, Q503, and Q504, output filter capacitors C511A and C511C, and the load consisting of V201, V202, V203, and V204 filaments. The same rectified output is also applied to the inner and outer oven, sensing elements R603 and R604 (fig. 1–17) and the METER SWITCH S503 circuitry. When switch S502 is in the STANDBY position the series regulator is removed from the circuit

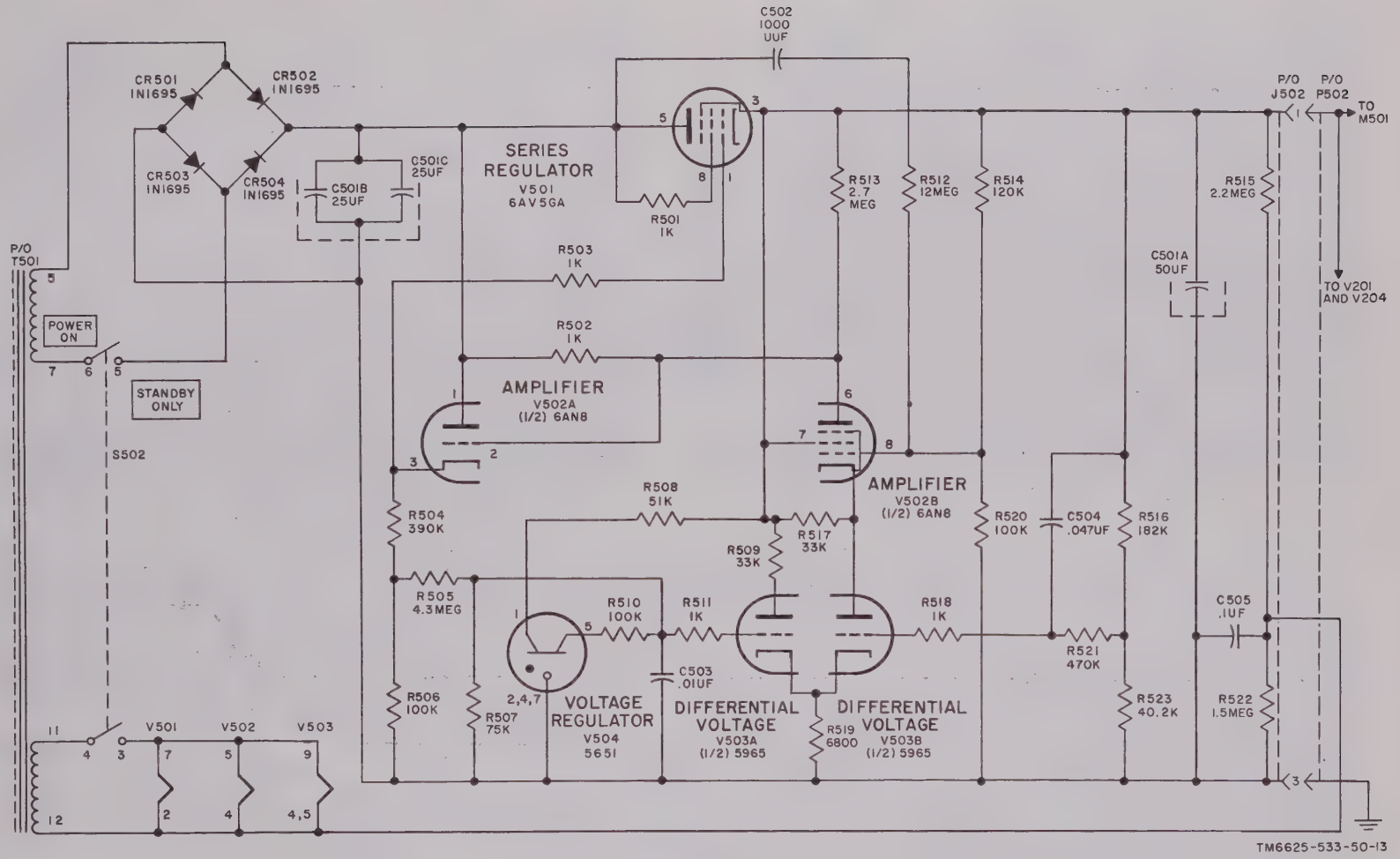
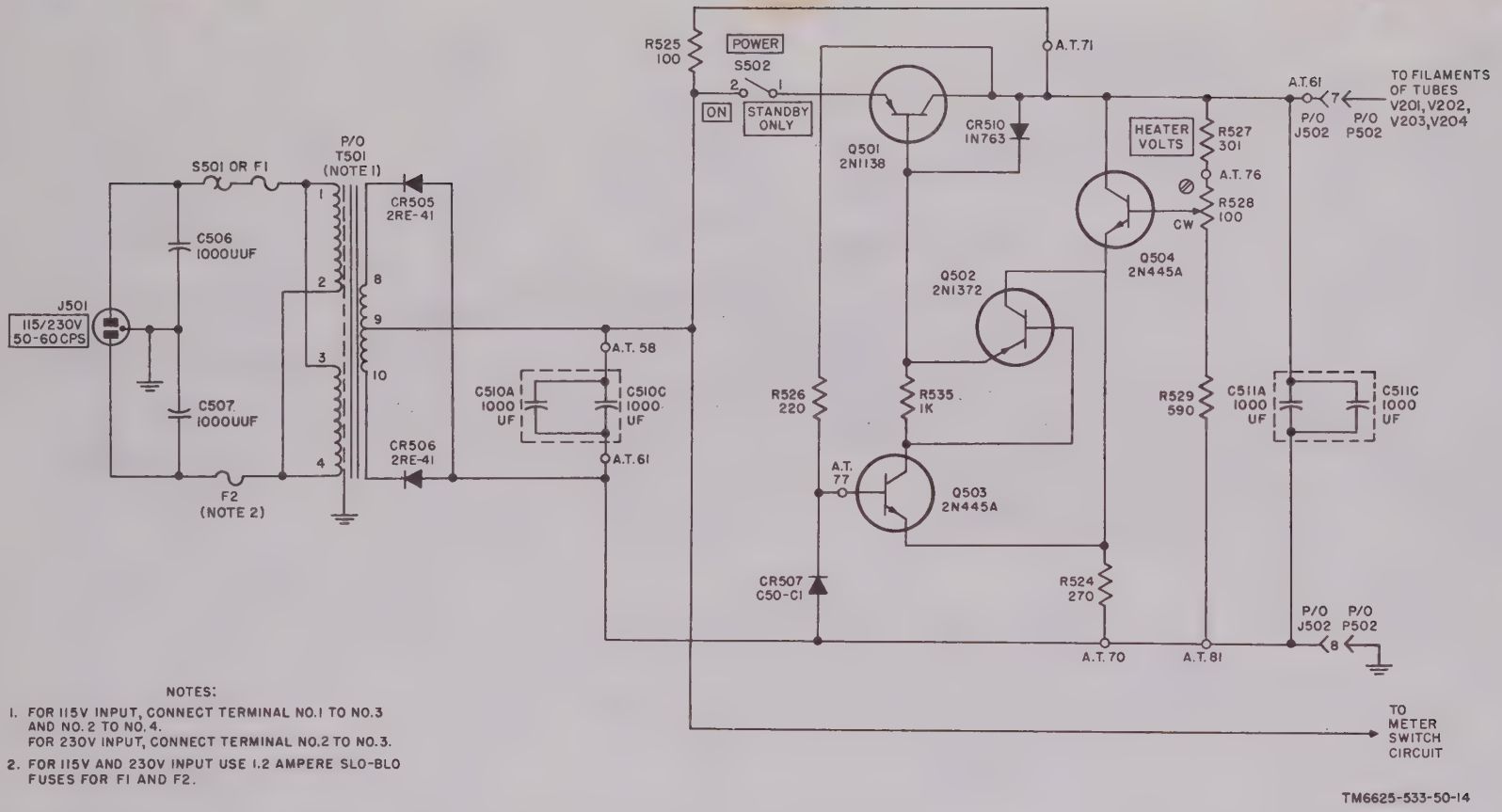


Figure 1–13. Regulated power supply (O–1106/URM–18A), schematic diagram.



NOTES:

1. FOR 115V INPUT, CONNECT TERMINAL NO.1 TO NO.3 AND NO. 2 TO NO. 4.
   FOR 230V INPUT, CONNECT TERMINAL NO.2 TO NO.3.
2. FOR 115V AND 230V INPUT USE 1.2 AMPERE SLO-BLO FUSES FOR F1 AND F2.

Figure 1–14. Filament power supply (O–1106/URM–18A), schematic diagram.

and the output current of the rectifier passes through dropping resistor R525. In the STANDBY position of S502, the filaments of V201 through V204 are supplied with unregulated dc. A portion of the power supply output, appearing across voltage divider R527, R528, R529, is sampled by Q504 base. The power supply output can be controlled by varying HEATER VOLTS control R528. The voltage at the cathode of Zener diode CR507 (and consequently at the base of Q503) remains the same level over large changes in current through the diode. Because of this and because of common-emitter resistor R524, the emitter currents of Q503 and Q504 vary inversely. Correction in the output voltage of the power supply is produced in a series of circuit actions. Each action produces a subsequent action. Assume the output voltage of the power supply increases due to a reduction of loading conditions. The voltage across R529 increases. Forward bias voltage of Q504 increases. Emitter-collector current of Q504 increases. Voltage across R524 increases. Forward bias voltage of Q503 decreases. Emitter-collector current of Q503 decreases. Voltage across R535 decreases. Forward bias voltage of Q502 decreases. Emitter-collector current of Q502 decreases. Driving current to the base of Q501 decreases. Emitter-collector current of Q501 decreases. Current to the load decreases. Output voltage of power supply decreases connecting the increase of output voltage. Resistors R526 and R535 are voltage-dropping resistors for CR507 and Q503, respectively. Diode CR510 protects Q501 from damage by preventing oscillations from developing. The output of the rectifier and filter is applied to the meter switch circuit.

1–13. Outer Oven Heater and Fan Motor Circuits (O–1106/URM–18A)

(fig. 1–15)

Power, 115 volts ac, is applied to the fan motor B501 and to the outer oven heater R601 from T501 primary terminals 1 and 2. Capacitor C508 is the fan motor B501 starting capacitor. In series with heater R601 is OVEN CYCLING-OUTER indicator DS501. In parallel with DS501 is voltage-limiting resistor R534. Also in series with R601 are two current-limiting resistors R607 and R608 and heat control thermostat S601. In parallel with S601 is C601, used to absorb any current surge.

1–14. Power Lamp and Inner Oven Heater Control Circuits (O–1106/URM–18A)

(fig. 1–16)

Secondary winding between terminals 15 and 16 of T501 provides power to the parallel circuit consisting of power lamp DS201, V505 filament, and V505 control grid through inner oven thermostat S602. Resistor R245 is a voltage dropping resistor. Secondary winding

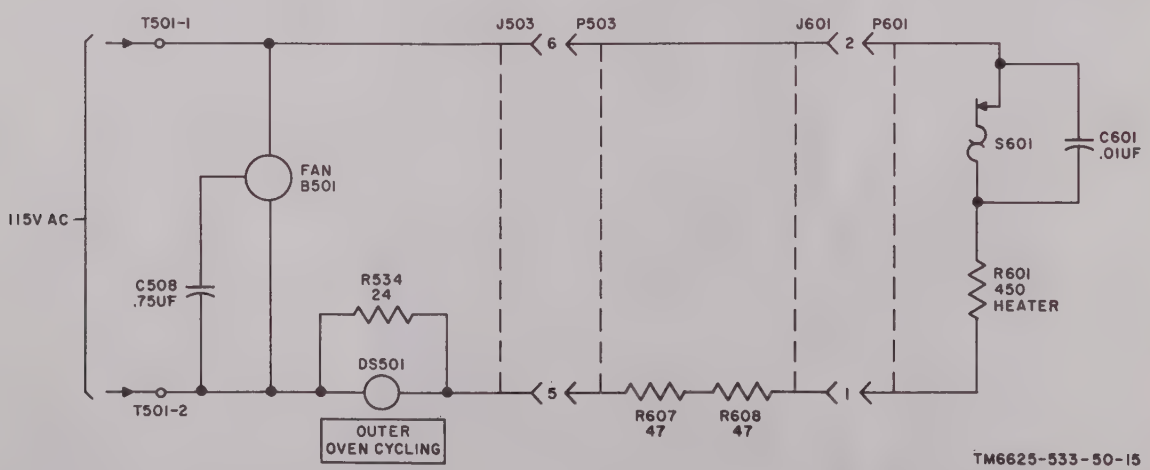


Figure 1–15. Outer oven heater and fan motor circuits (O–1106/URM–18A), schematic diagram.

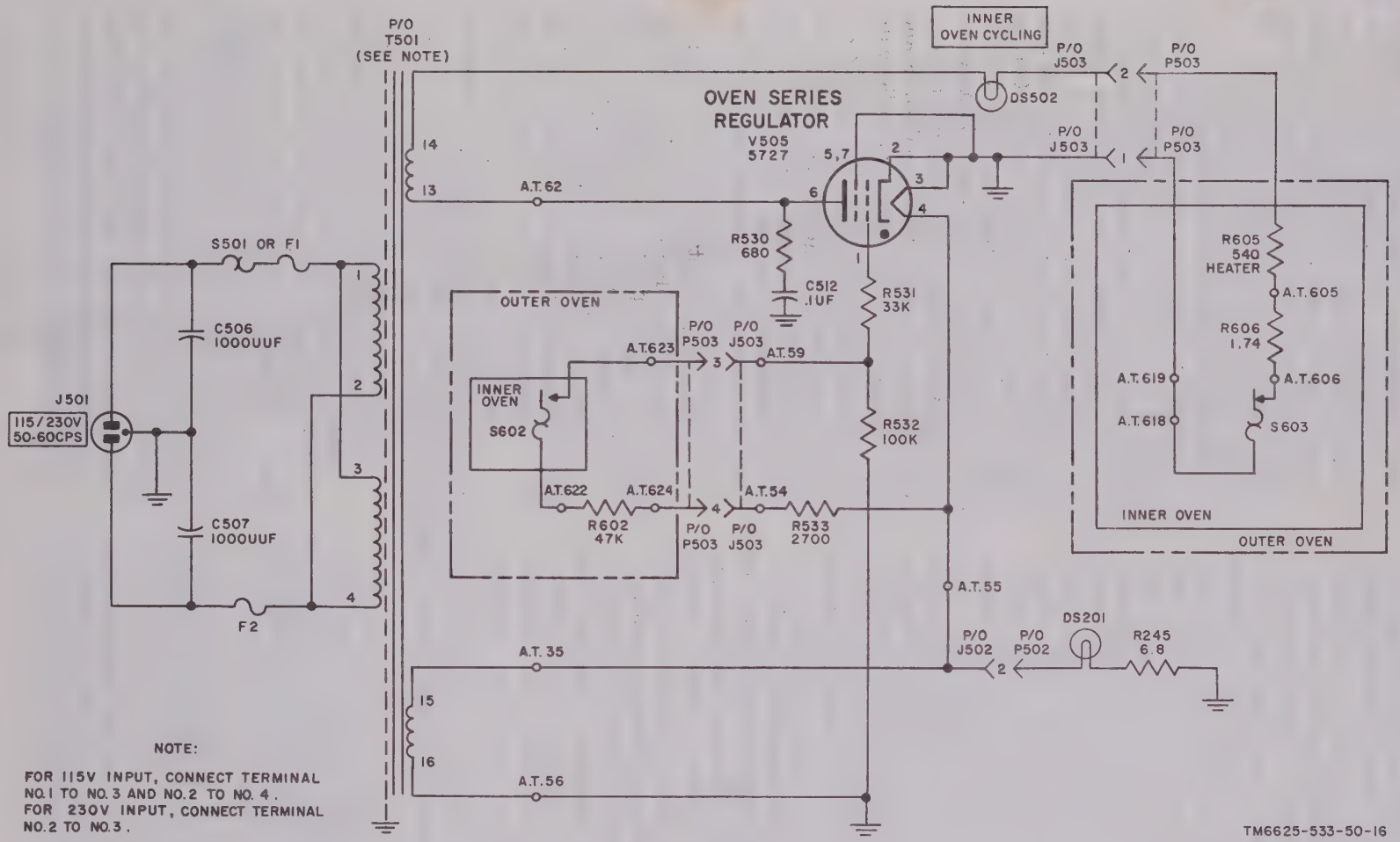


Figure 1–16. Power lamp and inner oven heater control circuits (O–1106/URM–18A), schematic diagram.

between terminals 13 and 14 of T501 provides power to a series circuit consisting of the plate to cathode circuit of V505, INNER-OVEN CYCLING lamp DS502, inner oven heater R605, inner oven anticipator R606, and inner oven protective thermoswitch S603. Power is applied to inner oven heater R605 when thyratron V505 conducts. When the temperature of the inner oven is below 85 ±3° C, thermoswitch S603 closes and completes the oven heater circuit through V505. When the temperature of the inner oven falls below approximately 70° C, thermostat S602 opens, applying a ground potential to the control grid of V505 through resistors R531 and R532. The ground potential condition fires V505 into conduction. When S602 is closed, an ac voltage is applied to the control grid of V505 preventing the tube from firing. This is due to the plate voltage and control grid voltage of V505 being 180° out of phase. When the control grid voltage is at a level to induce conduction of V505, then the applied plate potential is the wrong polarity to permit V505 to conduct. On the alternate half cycle of the line voltage, when the polarity of the applied plate voltage is correct, then the polarity of the applied control grid voltage prevents firing of the thyratron. The dc voltage is applied to the control grid through resistors R533 and R532. Resistor R531 is used to limit control grid current. The heater current to R605 is applied through INNER-OVEN CYCLING indicator lamp DS502 and protective resistor R606. Resistor R530 and capacitor C512 form a filter network that bypasses transients to ground.

1–15. METER SWITCH (O–1106/URM–18A)

(fig. 1–17)

a. General. METER SWITCH S503 provides a method of checking agc, the output of amplifier V204B, oscillator V201 operation, and calibrating inner and outer oven temperatures.

b. Detailed Operation. Detailed operation of S503 in the various switch positions is covered in (1) through (5) below.

(1) *Agc.* The agc voltage developed in the output of cathode follower V204A at the junction of R238 and CR203 induces a current to pass through contacts 1 and 6 of S503 front to the negative side of meter M501. The current path continues through and completes a path to ground through contacts 8 and 5 of S503 rear. Meter M501 indicates a current which is proportional to the agc voltage.

(2) *Output.* The output of output amplifier V204B at the junction of CR204 and C240 passes through contacts 2 and 6 of S503 front to the negative side of meter M501. The positive side of the meter is grounded through contacts 8 and 5 of S503 rear. For the same switch position, the agc voltage is grounded through load resistor R539 by way of contacts 1 and 12 of S503 front. Meter M501 indicates a current which is proportional to the output voltage rectified by CR204.

(3) *Osc Plate.* A voltage is taken at the junction of R203 and C204 in the plate circuit of V201 and applied through contacts 3 and 6 of S503 front to the negative side of meter M501. At the same time, 200 volts dc from the regulated power supply is applied through contacts 8 and 9 of S503 rear to the positive side of the meter. Current flow through meter M501 reflects the potential difference between the oscillator plate voltage and the 200-volt dc output of the regulated power supply. For the same switch position, the agc voltage is grounded through load resistor R539 by way of contacts 1 and 12 of S503 front.

(4) *Oven Temps-Inner.* In this switch position, M501 is used to indicate the balance of a bridge circuit. Resistors R543 and R604 form one arm of the bridge and R542 and R541 form the other arm. The bridge is grounded through R604 and R541. Resistor R604 is a temperature-sensitive device. As temperature increases, the resistance of R604 decreases. Diode CR509 is connected from the junction of R543 and R604 to the junction of R542 and R541, to form the center

arm of the bridge. The negative terminal of M501 is connected to the anode of CR509 through contacts 4 and 6 of S503 front and current-limiting resistor R540. The positive terminal of M501 is connected to the cathode of CR509 through contacts 10 and 8 of S503 rear. Meter M501 indicates the balance of the bridge. Six volts dc is applied to the bridge from the filament power supply through R537. This voltage is held at a constant value by Zener diode CR508. Ordinarily, the bridge is adjusted so that when the crystal is at correct operating temperature, the ratio of R604 to R543 is such that M501 indicates 26 microamperes (ua). When the temperature of the inner oven is low, the resistance of R604 is high. Under these conditions, the meter indication will be less than 26 ua. When the temperature of the oven is high, the resistance of R604 is low. Under these conditions, the meter indication will be greater than 26 ua. Resistor R540 is used to limit current. Corrections for errors in balance are made with INNER OVEN TEMP CAL. variable resistor R543. For the same switch position, the agc voltage is grounded through load resistor R539 by way of contacts 1 and 12 of S503 front.

(5) *Oven Temps-outer.* For this switch position, filament power supply voltage is applied from the junction of Zener diode CR508 and resistor R537 to voltage-dropping resistor R538, which is in series with a grounded parallel circuitry combination consisting of OUTER OVEN TEMP CAL. variable resistor R536 in one branch and the series combination of R603 and M501 in the other branch. Resistor R603 is connected to the positive terminal of M501 through contacts 8 and 11 of S503 rear. The negative terminal of M501 is grounded through contacts 5 and 6 of S503 front. Resistor R603 is a temperature-sensitive device. As temperature increases, the resistance of R603 decreases. Ordinarily, R536 is adjusted so that for a hot oven, M501 indicates 7 to 30 ua. A lowering of the oven temperature results in R603 resistance increasing. Under these conditions, M501 will indicate a lower than normal current valve. A rising of oven temperature will decrease the resistance of R603 resulting in M501 indicating a higher than normal current valve.

Section III. FUNCTIONING OF FREQUENCY MULTIPLIER CV–1518/URM–18A

1–16. Frequency Multiplier CV–1518/URM–18A, Block Diagram (fig. 1–18)

The CV–1518/URM–18A utilizes the 5-mc output of the frequency calibrator to provide standard frequency outputs of 10 mc and 100 mc. Signal paths and major functional sections of the unit are shown in the block diagram (fig. 1–18) and are discussed in *a* through *k* below. For complete circuit details, refer to the overall schematic diagram (fig. 4–5 ① and ②).

a. 1-mc to 10-mc Multiplier. The 1-mc to 10-mc multiplier amplifies the second harmonic of the 5-mc input signal from the frequency calibrator and applies the output 10-mc signal to the 10-mc phase detector.

b. 10-mc Phase Detector. The 10-mc pnase detector receives the 10-mc standard frequency input signal from the 10-mc multiplier and a 10-mc input signal from the 10-mc oscillator. Any difference in frequency between these two signals is converted to a dc voltage, which is used to control the bias on the reactance tube.

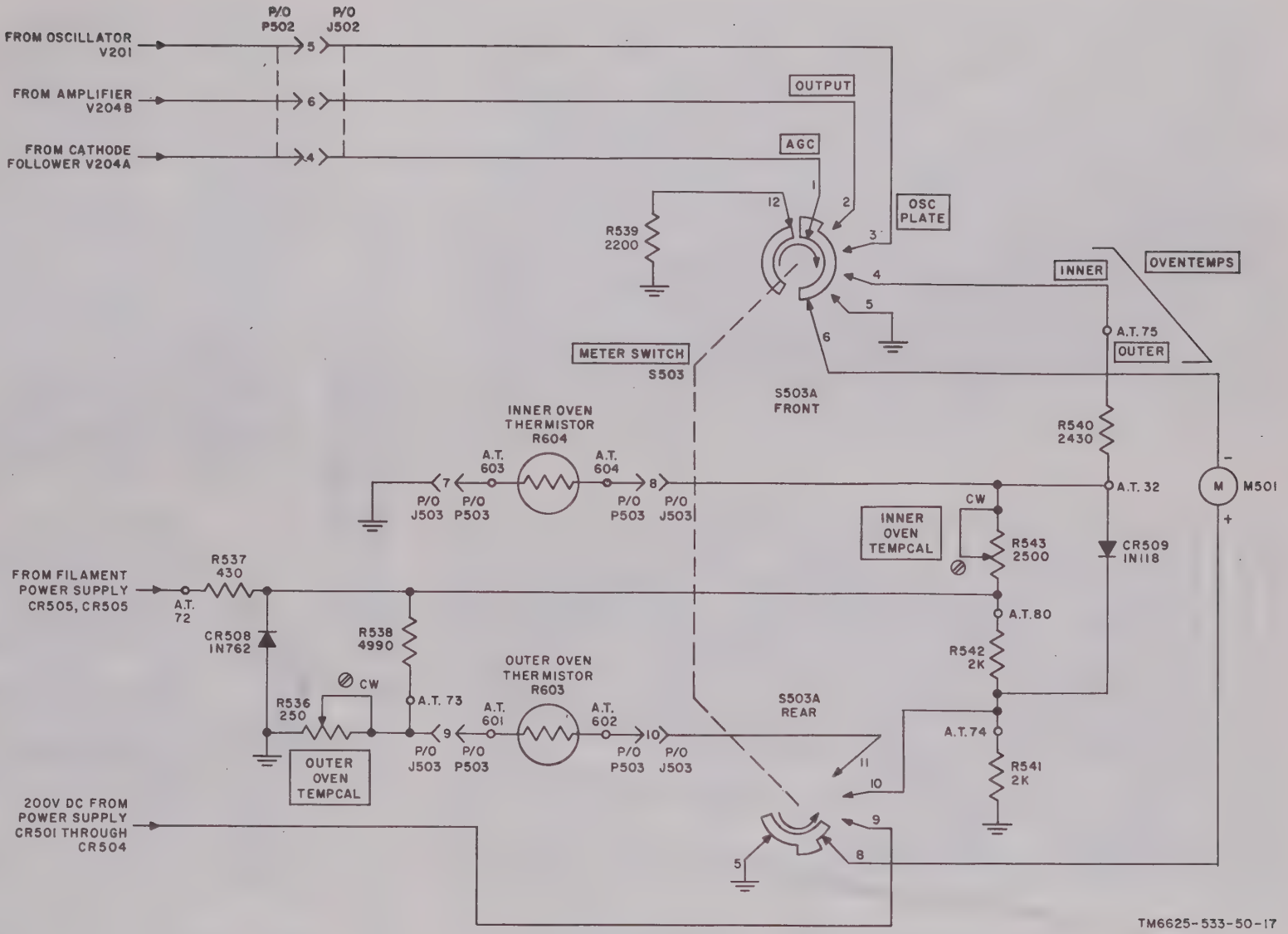


Figure 1–17. METER SWITCH S503 (O–1106/URM–18A), schematic diagram.

c. 10-Mc Oscillator and Reactance Tube. The 10-mc oscillator is a crystal-controlled oscillator. The oscillators frequency is also controlled by the output of the reactance tube. Oscillator outputs are fed to the 10-mc phase detector, the 10-mc amplifier, and the 10-mc to 100-mc multiplier.

d. 10-Mc Amplifier. The 10-mc amplifier amplifies the output of the 10-mc oscillator and reactance tube stage. The amplified 10-mc signal in turn is coupled to the OUTPUT 10-mc jack J201.

e. 10-Mc to 100-Mc Multiplier. The 10-mc to 100-mc multiplier amplifies the 10th harmonic of the 10-mc input signal from the 10-mc oscillator and reactance tube stage and in turn applies the 100-mc output signal to the 100-mc phase detector.

f. 100-Mc Phase Detector. The 100-mc phase detector receives the 100-mc signal from the 100-mc multiplier and a 100-mc signal from the 100-mc oscillator and reactance tube stage. A difference in frequency between the two signals generates a biasing potential in the unbalanced phase detector. The biasing potential is used to control the reactance tube.

g. 100-Mc Oscillator and Reactance Tube. The 100-mc oscillator is a crystal-controlled oscillator. The oscillators frequency is also controlled by the reactance tube. One oscillator output is coupled back to the 100-mc phase detector. The other oscillator output is coupled to the two 100-mc output amplifiers.

h. 100-Mc Amplifiers. The 100-mc amplifiers amplify the output of the 100-mc oscillator and reactance tube stage. The amplified outputs are coupled to 100-mc OUTPUT jack J301 and 100-mc OUTPUT jack J4.

i. B+ Power Supply. The B+ power supply rectifies the ac voltage input and in turn couples the output dc to the B+ voltage regulator.

j. B+ Regulator. The B+ voltage regulator regulates the input voltage from the B+ power supply so that changing load conditions of the power supply will receive a constant voltage. The output is a regulated +250 volts.

k. Unregulated Dc Filament Power Supply. The unregulated filament power supply uses an input of 105 to 125 or 210 to 250 volts ac at 50 to 60 cps to provide unregulated 6.3 volts dc to the filaments of the 10-mc and 100-mc stages.

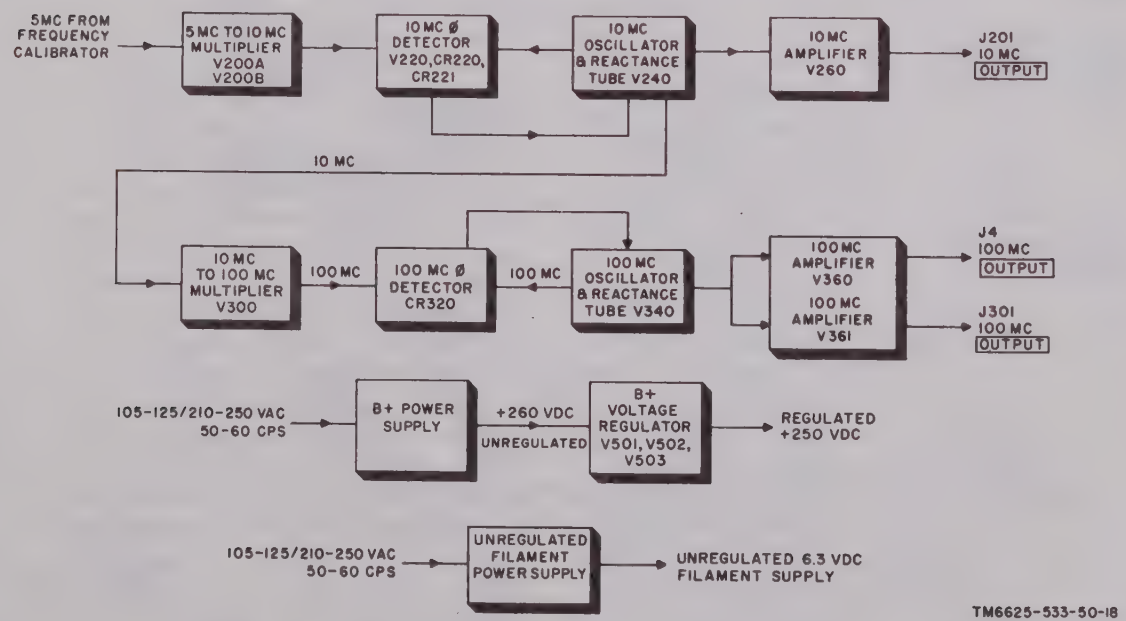

5MC FROM FREQUENCY CALIBRATOR
5 MC TO 10 MC MULTIPLIER V200A V200B
10 MC Ø DETECTOR V220, CR220, CR221
10 MC OSCILLATOR & REACTANCE TUBE V240
10 MC AMPLIFIER V260
J201 10 MC OUTPUT
10 MC
10 MC TO 100 MC MULTIPLIER V300
100 MC
100 MC Ø DETECTOR CR320
100 MC
100 MC OSCILLATOR & REACTANCE TUBE V340
100 MC AMPLIFIER V360
100 MC AMPLIFIER V361
J4 100 MC OUTPUT
J301 100 MC OUTPUT
105-125/210-250 VAC 50-60 CPS
B+ POWER SUPPLY
+260 VDC
UNREGULATED
B+ VOLTAGE REGULATOR V501, V502, V503
REGULATED +250 VDC
105-125/210-250 VAC 50-60 CPS
UNREGULATED FILAMENT POWER SUPPLY
UNREGULATED 6.3 VDC FILAMENT SUPPLY
TM6625-533-50-18

Figure 1–18. Frequency Multiplier CV–1518/URM–18A, block diagram.

1–17. Multiplier V200, 5 Mc to 10 Mc (CV–1518/URM–18A)
(fig. 1–19)

a. General. The 5-mc signal from the frequency calibrator is multiplied to 10-mc, amplified, and coupled to the 10-mc phase detector stage.

b. Detailed Operation. The 5-mc output signal of the frequency calibrator is applied to the control grid of V200A through coupling capacitor C209 and parasitic suppressor R201. Although the 5-mc input signal and all its harmonics are coupled to the control grid of V200A, the only signal amplified and appearing in the plate output circuit is the second harmonic of the input 5-mc signal. The output plate circuit contains a 10-mc tuned circuit consisting of L200 and C202. The output of the plate tuned circuit is coupled to the control grid of V200B through coupling capacitor C203. The plate output circuit of V200B is a 10-mc tuned resonant circuit consisting of C206 and L201. The amplified signal is transformer-coupled to L202 and fed directly to the 10 mc phase detector. The network consisting of resistor R204 and bypass capacitor C204 provide a fixed cathode bias for V200A and V200B. Resistor R226 and inductor L202 form a high-impedance path for the incoming signal to V200A. Resistor R202 completes the dc grid return to ground. Capacitor C229 bypasses R202. Resistor R205 is a dc grid return to ground for the control grid of V200B. Plate supply voltage is supplied by the regulated power supply and is applied to the plate circuits of V200A and V200B through contacts 3 and 7 of S200 and through decoupling capacitor C208. For V200A, the supply voltage is applied across plate voltage-dropping resistor R203. Capacitor C201 is the decoupling

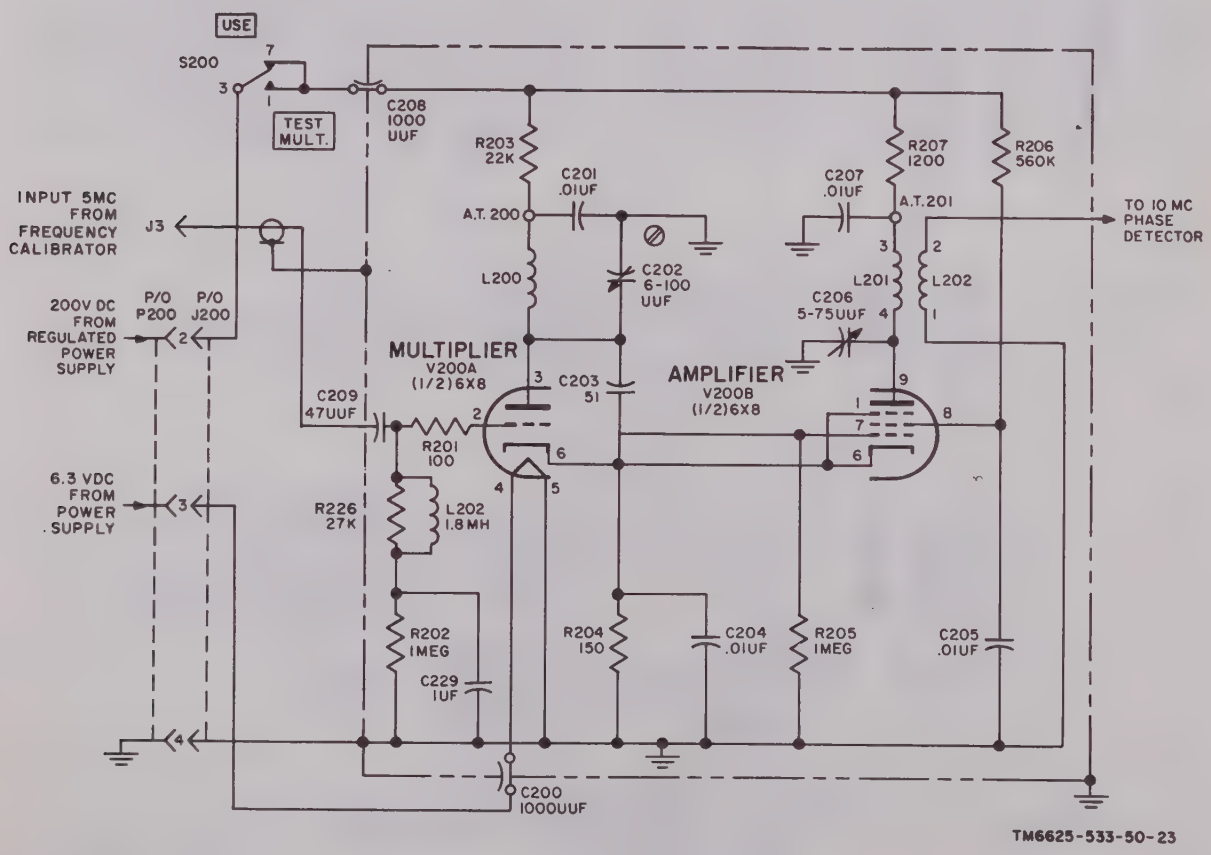


Figure 1–19. Multiplier, V200, 5 to 10 mc (CV–1518/URM–18A), schematic diagram.

capacitor. For V200B, the voltage is applied across plate voltage-dropping resistor R207. Capacitor C207 is the decoupling capacitor. Screen voltage for V200B is applied across screen voltage-dropping resistor R206. Capacitor C205 is the decoupling capacitor. The filament voltage for both tubes is supplied by the unregulated dc filament power supply and applied through decoupling capacitor C200.

1–18. Phase Detector V220, 10 Mc (CV–1518/URM–18A)
(fig. 1–20)

a. General. The output of the 1-mc multiplier and the output of the 10 mc oscillator are compared for their phase differences and the resultant, converted to a dc bias, is applied to the reactance tube stage V240A.

b. Detailed Operation. The output of the 10-mc oscillator is applied to the control grid of V220. The cathode follower output of V220 developed across R223 and R224, is coupled to the center tap of the secondary winding of L220 and the movable arm of R221 through coupling capacitor C225. The output of the 1-mc to 10-mc multiplier is applied to the primary winding of L220 and inductively coupled to the secondary. The difference in phase of the two signals across the secondary of V220 is rectified by CR220 and CR221, filtered by C222, and applied as a dc voltage across voltage-divider network R220, R221, and R222. This dc voltage is then applied as bias to reactance tube V240A. The current through the voltage-divider network is indicated on 10-mc PHASE DETECTOR meter M200. Capacitor C223 acts as a bypass capacitor for the meter circuit. An auxiliary meter can be connected through J200. The combination of C221, C220, and the secondary of L220 forms a tuned circuit, resonating at 10-mc. Resistor R225, together with R224, forms the dc control grid return for V220. Plate voltage for V220 is supplied by the regulated power supply and applied directly to the plate of V220. B+ voltage decoupling capacitor C224 is connected directly to the plate of V220. Unregulated dc filament voltage is applied directly to the filaments with capacitors C227 and C226 used as bypass capacitors.

1–19. Oscillator and Reactance Tube V240, 10 Mc (CV–1518/URM–18A)
(fig. 1–21)

a. General. The input signal from the phase detector stage through the action of reactance tube V240A locks 10-mc oscillator V240B into an exact multiple of the 5-mc signal generated by the frequency calibrator. One signal output of this stage is coupled to the following 10-mc amplifier V260. The other signal output of this stage is coupled to the input of the 100-mc channel (control grid of V300A).

b. Detailed Operation. The frequency of the oscillator plate feedback signal to energize crystal Y200 at the correct frequency is controlled by C249, C250, and C248 in parallel with C256, and reactance tube V240A. Capacitors C252 and C240 are the coarse and fine level adjustments, respectively, of the plate feedback signal. Inductance L242 and C247 are part of the reactive components that determine the frequency of the oscillator plate feedback signal to Y200. The crystal circuit signal is coupled by C246 through decoupling resistor R244 to the control grid of V240B. The grid return for V240B control grid is R243. A portion of the oscillator crystal circuit signal is applied to a voltage divider consisting of C241 and R240. The amount of rf voltage across R240 is coupled through C242 to the control grid of V240A to produce the rf plate current output. The phase relationship of the reactance tube rf plate current and rf voltage produces the reactive component effect presented by the reactance tube in the crystal oscillator circuit. The output of the phase detector stage is also coupled to the control grid of the reactance tube through R241. The phase detector signal controls the amount of V240A rf plate current flow. The control of plate rf current flow changes the magnitude of reactance represented by the reactance tube. Cathode resistor R242 and cathode bypass capacitor C243 provide fixed cathode bias for the reactance tube. Additional bias voltage across R242 is also applied from the plate power supply through the decoupling network consisting of bypass capacitor C245 and voltage-dropping resistor R246. The same plate power supply source is also used to supply V240 screen-grid

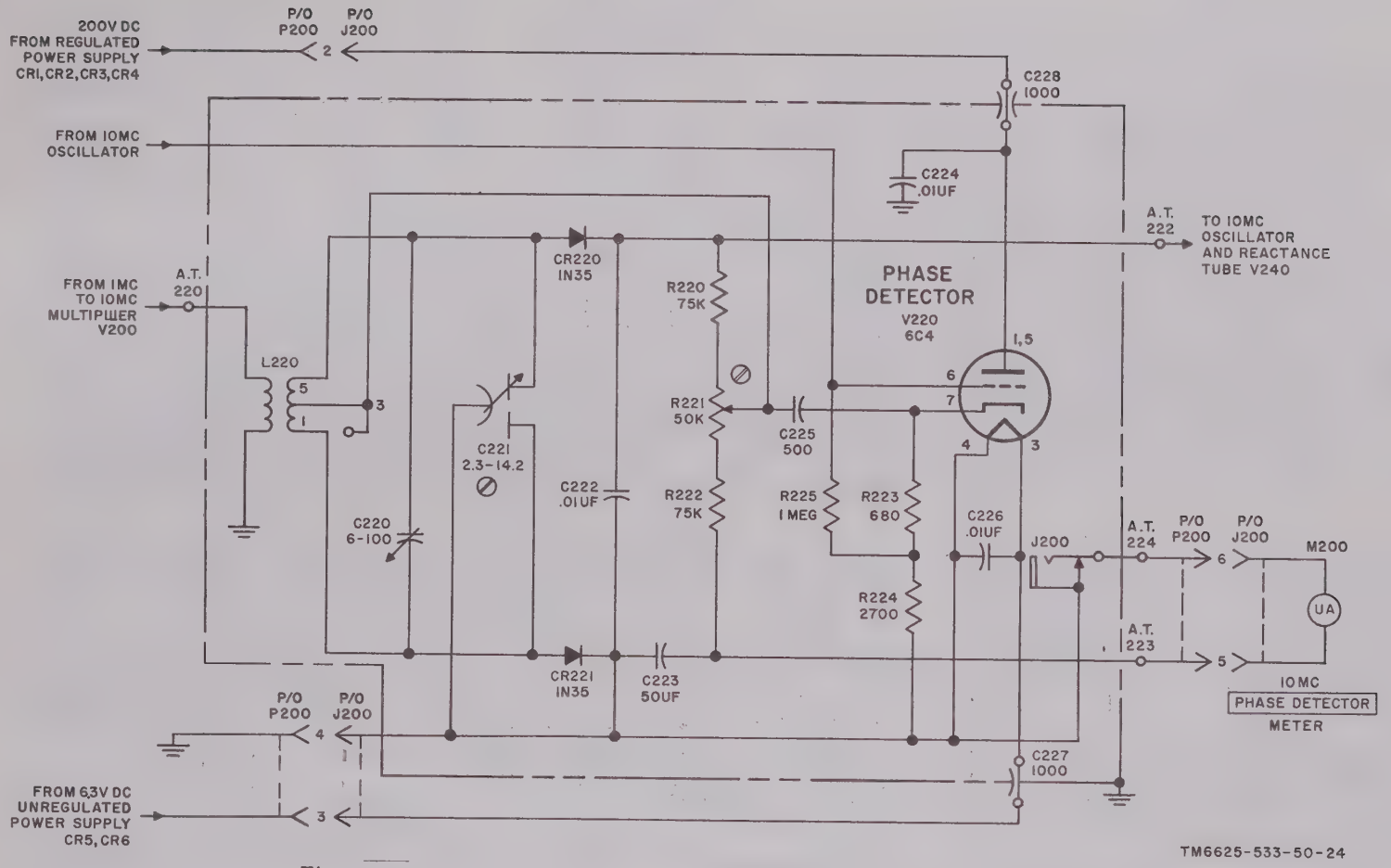


Figure 1-20. Phase detector V220, 10 mc (CV-1518/URM-18A), schematic diagram.

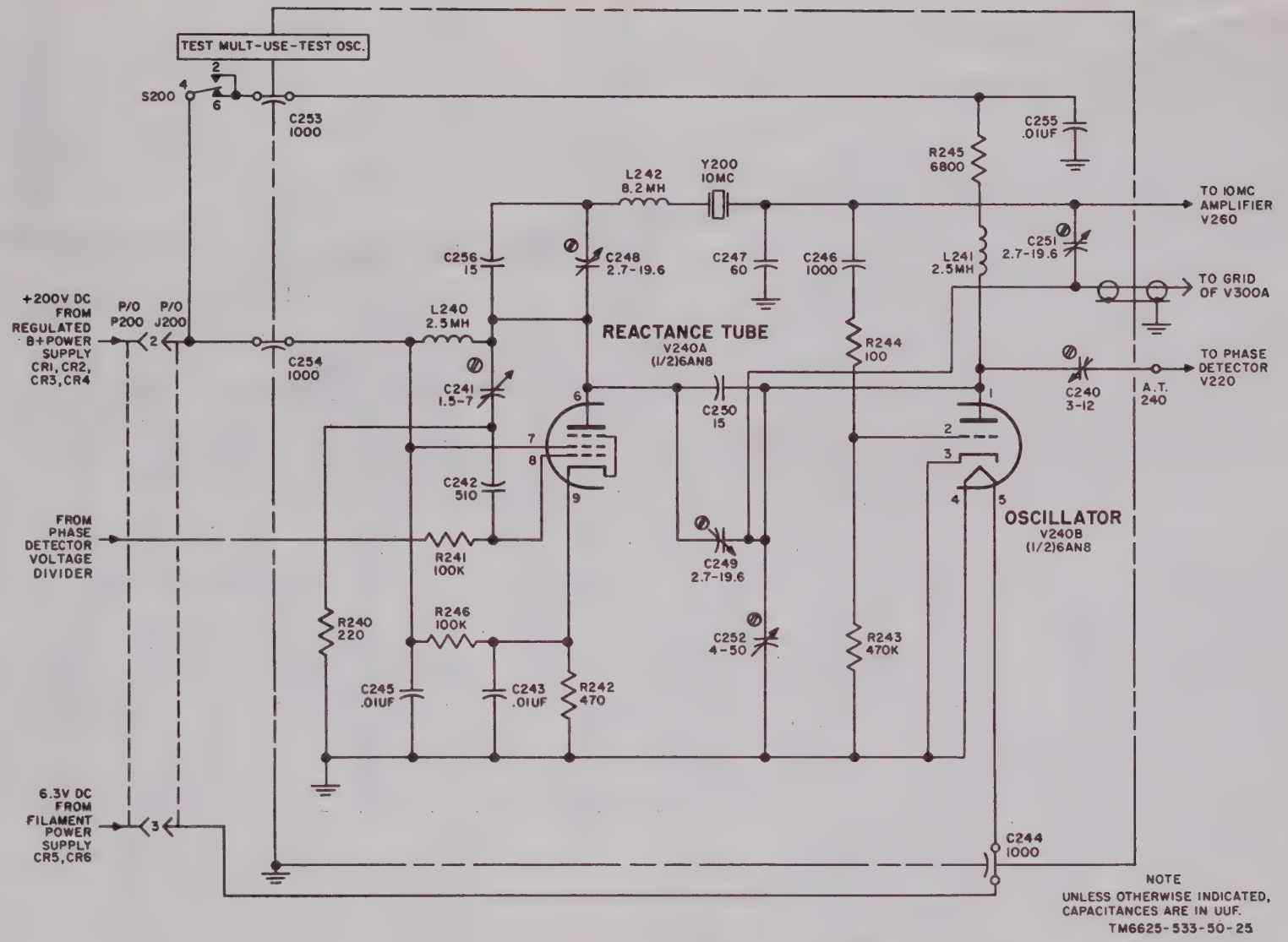


Figure 1–21. Oscillator and reactance tube V240, 10 mc (CV–1518/URM–18A), schematic diagram.

1–22. Phase Detector CR320, 100 Mc (CV–1518/URM–18A) (fig. 1–24)

a. General. The output signal of the 100-mc oscillator and the output signal of the 10 mc to 100 mc multiplier (V300) are applied to the phase detector. A resulting dc voltage is developed due to rectification. The magnitude of the dc voltage is dependent on the phase difference between the two input signals. The dc voltage is used as bias for reactance tube V340A in the following stage.

b. Detailed Operation. The combined outputs of the 100 mc oscillator and the 100-mc multiplier are applied to the tuned tank circuit consisting of C320, C321, and L320. A portion of the tuned tank circuit is tapped off from L320 and rectified by CR320. Capacitor C322 filters the rectified output as if flows through voltage-dropping resistor R320 and meter M300. Capacitor C323 is used to bypass M300. Jack J300 is connected in series with M300 and enables use of an auxiliary meter. The rectified, filtered output to the following stage (reactance tube V340A) is coupled from the junction of C322, R320, and CR320.

1–23. Oscillator and Reactance Tube V340, 100 Mc (CV–1518/URM–18A) (fig. 1–25)

a. General. The input signal from the unbalanced phase detector controls reactance tube V340A to lock in overtone crystal oscillator V340B at 100 mc. The oscillator output is coupled to amplifiers V360 and V361 in the following stage.

b. Detailed Operation. The frequency of the oscillator plate feedback signal to energize crystal Y300 at the correct overtone frequency is controlled mainly by the reactive elements of C351, L345 and reactance tube V340A. Capacitor C350 and inductor L344 are used to compensate for the crystal holder capacitance. Capacitors C352 and C349 control the signal feedback level and also contribute to controlling the frequency of the oscillator plate feedback signal. Capacitor C346 and inductor L343 form a tank circuit which controls the frequency of the signal that is applied to the control grid of V340B through coupling capacitor C345. Resistor R346 decouples the reactive elements of the crystal circuit and V340B control grid tank circuit. The grid return for the control grid of V340B is R345. The oscillator

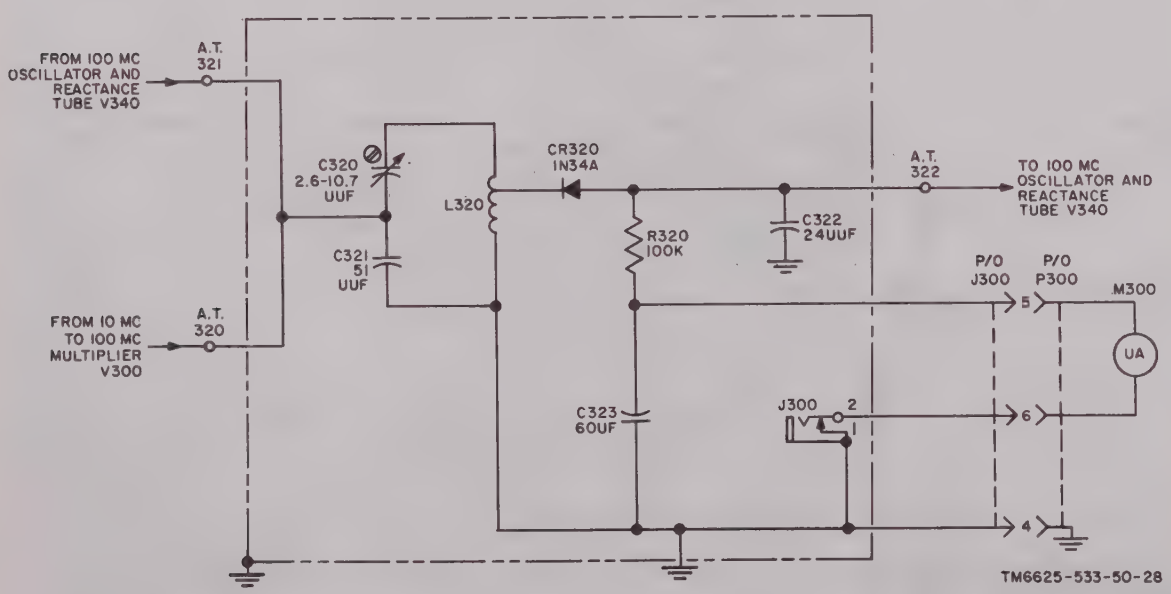


Figure 1–24. Phase detector CR320, 100 mc (CV–1518/URM–18A), schematic diagram.

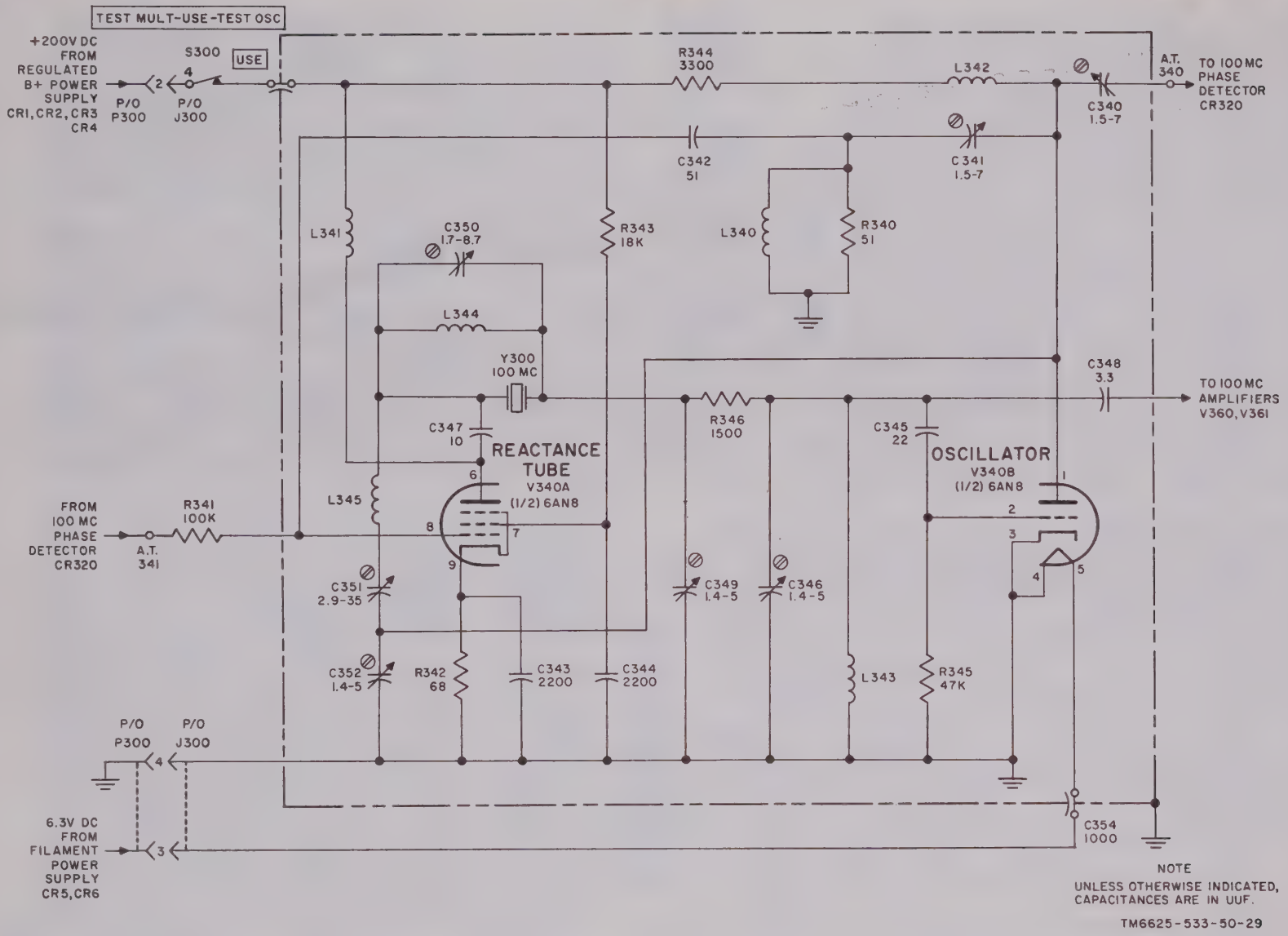


Figure 1–25. Oscillator and reactance tube V340, 100 mc (CV–1518/URM–18A), schematic diagram.

plate signal is also applied to a voltage-dividing network consisting of C341 and L340 in parallel with R340. A portion of the voltage-dividing network is coupled through C342 to the control grid of V340A to produce the rf plate current output. The phase relationship of the reactance tube rf plate current and rf voltage produces the reactive component effect presented by the reactance tube in the crystal oscillator circuit. The output of the unbalanced detector stage is also coupled to the control grid of the reactance tube through R341. The detector signal controls the amount of V340A rf plate current. The control of plate rf current changes the magnitude of reactance represented by the reactance tube. Cathode bias for V340A is developed across R342. Capacitor C343 bypasses R342. Plate voltage is applied to V340A through rf choke L341. Voltage to V340A screen grid is applied through voltage-dropping resistor R343 and is bypassed by C344. Plate voltage to V340B is applied through voltage-dropping resistor R344 and rf choke L342. Filament voltage is applied to pins 4 and 5 of V340 and bypassed by decoupling capacitor C354.

1–24. Amplifiers V360 and V361, 100 Mc (CV–1518/URM–18A)
(fig. 1–26)

a. General. The output of the 100-mc oscillator and reactance tube V340 is amplified by V360 and V361 and their outputs are applied to 100-mc OUTPUT to 1112-B J4 and 100-mc OUTPUT jack J301.

b. Amplifier V360. The 100-mc output from the oscillator is applied to the control grid of V360 through coupling capacitor C360. The amplified output appears in the 100-mc tuned circuit consisting of inductor L360 and variable capacitor C364. The output signal is transformer-coupled to L361 and applied directly to J4. Cathode bias is developed across R361 and is bypassed by C361. The control grid return resistor is R360. Screen voltage is applied through voltage-dropping resistor R362 and decoupled by C362. Plate supply voltage is applied through voltage-dropping resistor R367 and decoupled by C363.

c. Amplifier V361. The 100-mc output from the oscillator is also applied to the control grid of V361 through coupling capacitor C365. The amplified output appears in the 100-mc tuned circuit consisting of variable capacitor C369 and inductor L362. The output signal is transformer-coupled to L363 and applied to 100-mc OUTPUT jack J301 through coupling capacitor C372. The control grid return resistor is R363. Cathode bias is developed across R200 and R364 and bypassed by C366. Screen voltage is applied through voltage-dropping resistor R365 and decoupled by C367. Plate supply voltage is applied through voltage-dropping resistor R368 and decoupled by C368. Plate voltage is supplied to V361 and V360 from the 200-volt regulated power supply through contacts 4 and 2 or 6 of S300. Capacitors C371 and C373 are used for decoupling. Filament voltage is applied to pin 3 of both tubes through decoupling capacitor C370 from the unregulated dc filament power supply.

1–25. B+ Power Supply (CV–1518/URM–18A)
(fig. 1–27)

a. General. Line source power of 115 or 230 ac volts is applied to T1 and the output is rectified and filtered. The rectified, filtered dc voltage is then applied to the B+ power supply regulator.

b. Detailed Operation. Figure 1–27 shows the primary of T1 connected for 115-volt operation. Primary power is applied to the primary windings of T1 through P1, fuses F1 and F2, and POWER-OFF switch S1. Capacitors C3 and C4 are used to bypass high-frequency signals to ground. Primary winding power of T1 is inductively coupled to the secondary winding. The diode arrangement of CR1 through CR4 results in full wave rectification of the 60 cycle ac signal. During one half of the ac cycle, terminal 10 is positive with respect to terminal 12. With this condition existing, electron flow is from T1 terminal 11 through pi-type filter network CR2 and CR1 and to T1 terminal 10. During the alternate half cycle, the electron flow is from T1 treminal 11 through pi-type filter network CR4 and CR3 and to T1 terminal 12. The pi-type filter network consists of R1, R2, R3, C1A, C1B, C1C, and C1D. The rectified positive dc voltage generated at the junction of R3 and C1D is then coupled to the B+ power supply regulator.

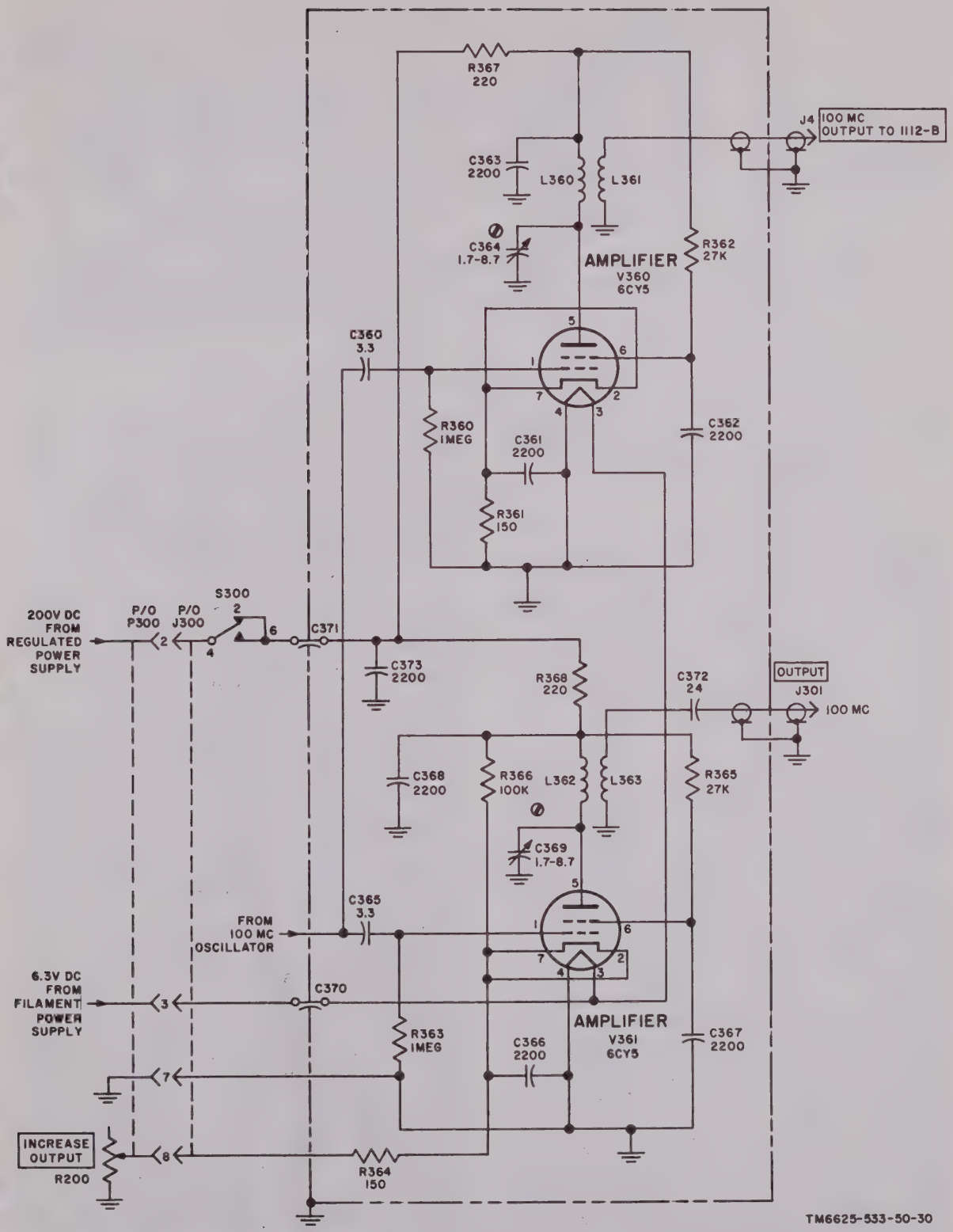


Figure 1–26. Amplifiers V360 and V361, 100 mc (CV–1518/URM–18A), schematic diagram.

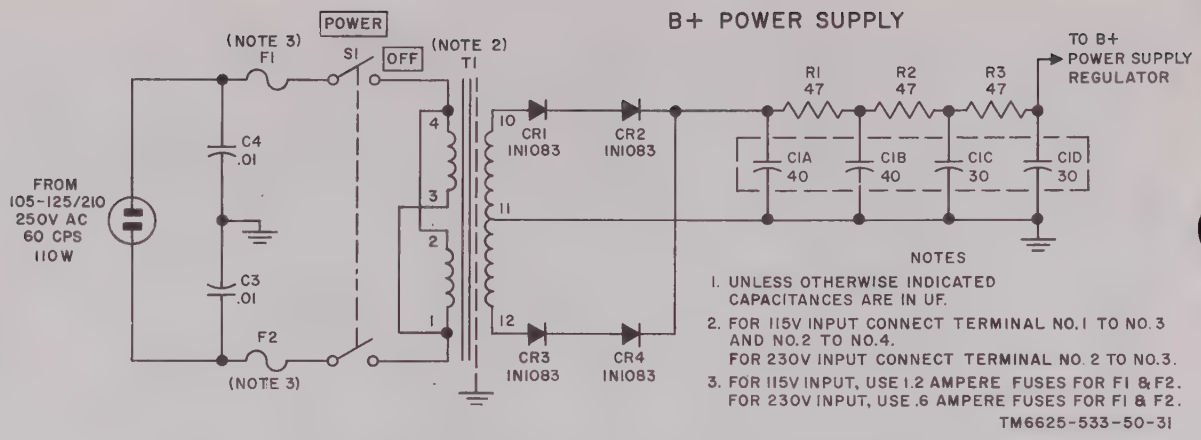


Figure 1–27. B+ power supply (CV–1518/URM–18A), schematic diagram.

1–26. B+ Power Supply Regulator V501, V502, and V503 (CV–1518/URM–18A)
(fig. 1–28)

a. General. The voltage of the B+ power supply is applied to the B+ power supply regulator consisting of amplifier V502A, voltage standard V503, cathode amplifier V502B, and series regulator V501. The circuitry of the B+ power supply regulator maintains a constant output of +250 volts direct current (vdc). It compensates for variations in load conditions or changes in the B+ power supply output voltage. The output voltage of the B+ power supply regulator is used to supply plate voltage, screen grid voltage, and for some conditions as bias for the signal conducting stages of the CV–1518/URM–18A.

b. Detailed Operation. A portion of the regulated output voltage is applied to the grid of V502B which has a fixed constant cathode bias due to the action of voltage regulator V503. The output of V502B controls the cathode bias of V502A. The output of V502A is applied to the control grids of series regulator V501. Depending on the control grid potential of V501, the current through V501 is increased or decreased. Assume that the power supply regulator output voltage increases. The increased voltage is distributed across a voltage-divider network consisting R504, R505, R507, and R508. That portion of increase across R507 and R508 is applied through R506 to the control grid of V502B. The response to this sudden variation is increased through C508. The increase of potential on the control grid of V502B causes an increase in the current flow through V502B. The increased plate current of V502B reduces the positive voltage level at the plate of V502B. This decrease in plate voltage causes the cathode of V502A to become more negative. The more negative potential on the cathode of V502A increases current flow through the tube, causing a decrease in positive plate potential of V502A and a decrease of potential at the control grids of V501. The reduced positive potential on the control grids of V501 decreases current flow through V501, thereby decreasing the voltage output of the B+ power supply regulator. Assume another condition in which the voltage output of the B+ power supply regulator decreases. This decrease of potential is also applied to the control grid of V502B and in turn reduces its plate current flow. This reduced plate current flow of V502B will allow the bias potential on the cathode of V502A to become more positive, thereby decreasing V502A plate current and applying a more positive potential on the grids of V501 from the more positive plate potential of V502A. The positive control grid potential will increase plate current flow through V501 and increase the voltage output of the B+ power supply regulator. Voltage variations from the B+ power supply are compensated for in the following manner. Sudden variations from the B+ power supply are coupled to the control

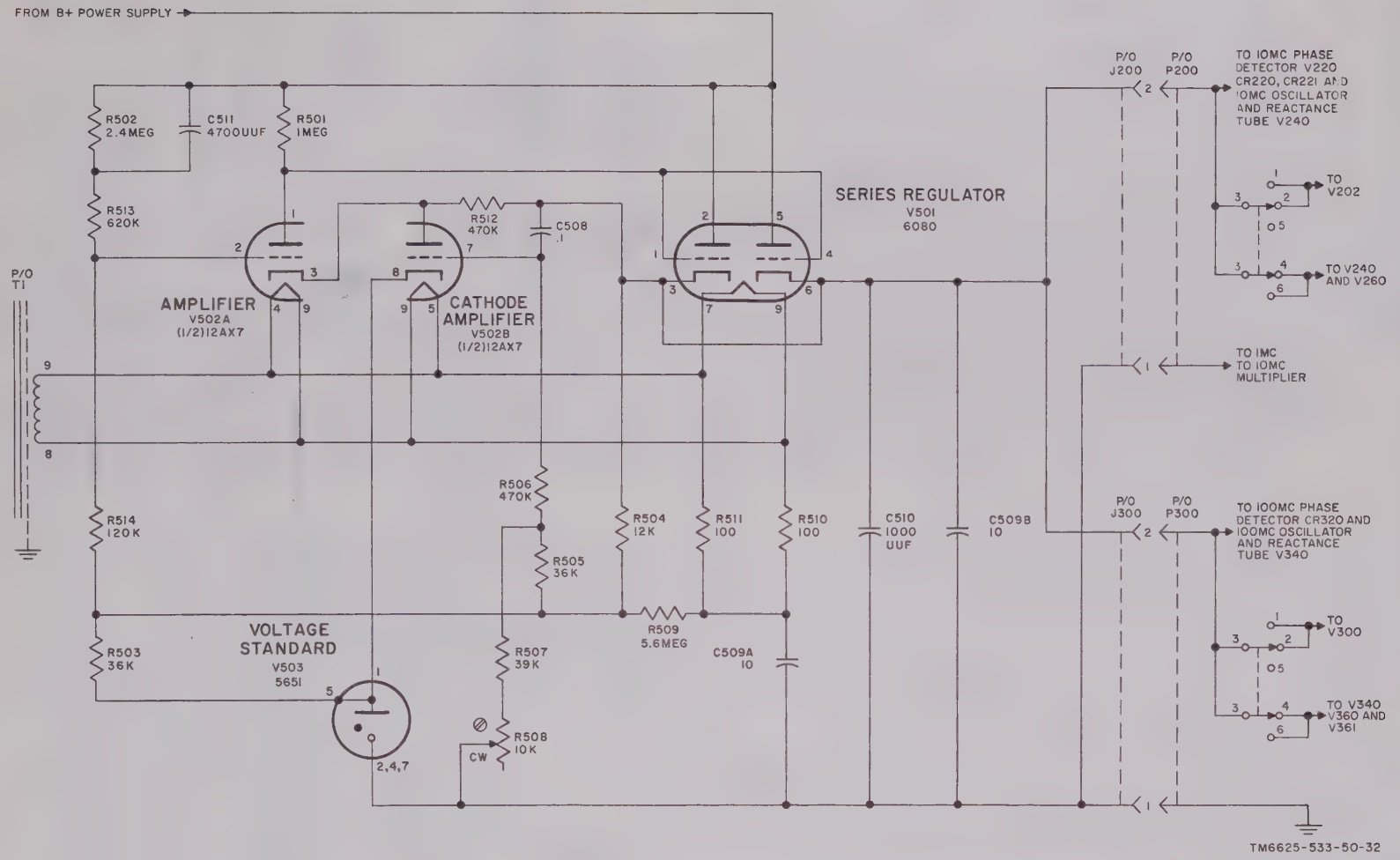


Figure 1–28. B+ power supply regulator V501, V502, and V503 (CV–1518/URM–18A), schematic diagram.

grid of V502A through R502 and R513 and cause the plate potential of V502A to vary accordingly. The plate output potential of V502A is applied to the control grids of V501 and controls the V501 plate current. The plate current change of V501 will compensate for the B+ power supply voltage variation. Capacitor C511 prevents momentary rf or noise pulses from affecting the regulator. Capacitors C509A, C510, and C509B are output voltage filter capacitors. Resistors R514, R503, and tube V503 form the dc grid return to ground for V502A. Resistors R501 and R512 are the plate voltage-dropping resistors for V502A and V502B. Filament voltage is supplied by the transformer T1 secondary, terminals 9 and 8, to the filaments of V501 and V502, and current-limiting resistors R510 and R511 with C509A as decoupling capacitor. Resistor R509 prevents interaction between the filaments and the cathode of V501.

1–27. Unregulated Dc Filament Power Supply (CV–1518/URM–18A) (fig. 1–29)

a. General. The 115 or 230 volts ac is applied to T1 and the output is rectified and filtered to produce the unregulated dc filament voltage. The unregulated dc filament voltage is applied to filaments of the signal conducting stages of the CV–1518/URM–18A.

b. Detailed Operation. Power (para 25*b*) is inductively coupled to the T1 secondary winding between terminals 7 and 5. During one half of the cycle of the ac input voltage, CR5 will conduct electrons from T1 secondary winding terminal 7 through the filter section to T1 secondary winding terminal 6. On the alternate half of the ac cycle, CR6 will conduct electrons from T1 secondary winding terminal 5 through the filter section to T1 secondary winding terminal 6. The action produces full-wave rectification for each cycle of input ac voltage. The combination of L1, C2A, C2B, and C2C forms a choke input filter network.

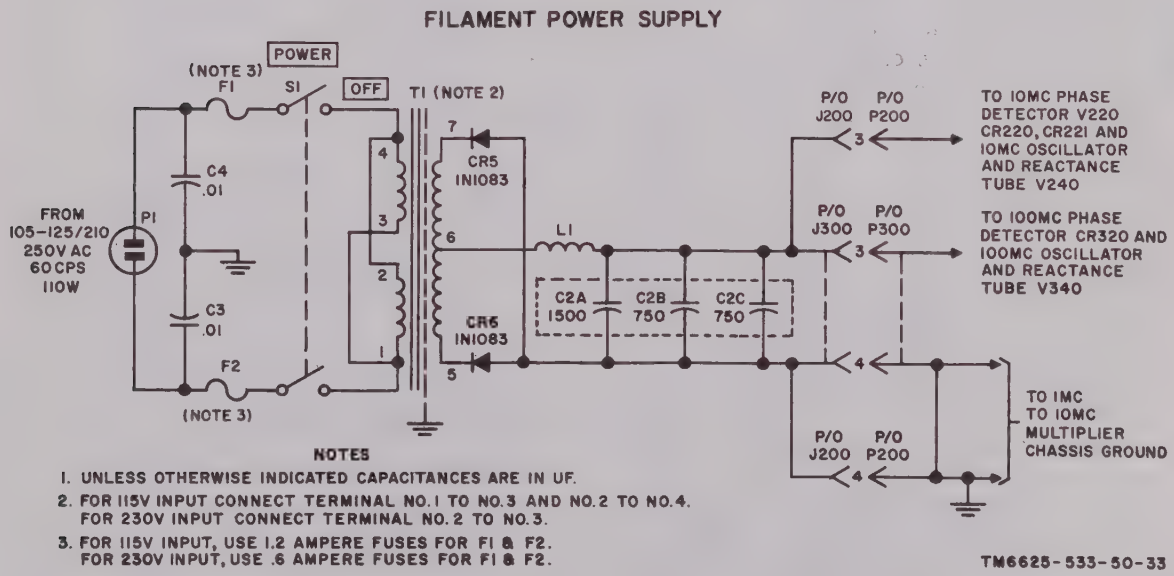


Figure 1–29. Unregulated dc filament power supply (CV–1518/URM–18A), schematic diagram.

1–28. Frequency Divider CV–1517/URM–18A, Block Diagram (fig. 1–30)

The frequency divider uses the 5-mc output from the frequency calibrator to provide standard frequency sine-wave outputs and standard frequency square-wave outputs. Signal paths and major functional sections of the unit are shown in figure 1–30 and are discussed in *a* through *i* below. For complete circuit details, refer to the overall schematic diagram (fig. 4–6).

a. Plug-In Unit 1114-P1, 1 Mc. The 1-mc plug-in unit 1114-P1 receives the 5-mc output from the frequency calibrator and generates a 1-mc standard frequency sine-wave output, which is applied to OUTPUT 1 MC jack J101 and another 1-mc sine-wave output which is applied to DRIVING FREQ switch S801.

b. DRIVING FREQ Switch S801. DRIVING FREQ switch S801 receives a 1-mc sine wave from 1 mc plug-in unit 1114-P1 and applies it to the input of the pulse shaper. The 1-mc square-wave output of the pulse shaper goes through the switch to 100-kc plug-in unit 1114-P2. The switch also receives a 100-kc square wave from 100-kc plug-in unit 1114-P2 and applies it to 10-kc plug-in unit 1114-P3.

c. Pulse Shaper. The pulse shaper receives a 1-mc sine wave from 1-mc plug-in unit 1114-P1 through DRIVING FREQ switch S801 and converts it to a 1-mc square wave. The 1-mc square wave is applied through DRIVING FREQ switch S801 to 100 kc plug-in unit 1114-P2.

d. Plug-In Unit 1114-P2, 100 Kc. The 100-kc plug-in unit 1114-P2 receives a 1-mc square wave from DRIVING FREQ switch S108 and generates three outputs; a 100-kc sine wave to OUTPUT 100 kc ∼ jack J201, a 100-kc square wave to OUTPUT 100 kc ∼ jack J202, and a 100-kc square-wave signal to DRIVING FREQ switch S801.

e. Plug-In Unit 1114-3, 10 Kc. The 10-kc plug-in unit 1114–3 receives a 100-kc square wave from 100-kc plug-in unit 1114-P2 through DRIVING FREQ switch S801 and generates three outputs; a 10-kc sine wave to OUTPUT 10 kc jack J301, a 10-kc square wave to OUTPUT 10 kc ∼ jack J302, and a 10-kc square wave to plug-in unit 1114-P4.

f. Plug-In Unit 1114-P4, 1 Kc. The 1-kc plug-in unit 1114-P4 receives a 10-kc square wave from 10-kc plug-in unit 1114-P3 and generates three outputs; a 1-kc sine wave to OUTPUT 1 kc jack J402, a 1-kc sine wave to OUTPUT 1 kc jack J401, and a 1-kc square wave to .1 kc plug-in unit 1114-P5.

g. Plug-In Unit 1114-P5, .1 Kc. The .1-kc plug-in unit 1114-P5 receives a 1-kc square wave from 1-kc plug-in unit 1114-P4 and generates a 100-cycle sine-wave output to OUTPUT 100C jack J501.

h. Power Supply. The power supply rectifies the ac voltage input and filters the rectified output. The rectified, filtered output dc voltage is coupled to the power supply regulator.

i. Power Supply Regulator. The power supply regulator regulates the input voltage from the power supply so that changing load conditions of the power supply regulator will receive a constant voltage. The output becomes a regulated −18 vdc.

1–29. DRIVING FREQ Switch S801 (fig. 1–31)

a. General. DRIVING FREQ switch S801 is a three-position switch. The positioning of the switch to 5 mc, 1 mc, or 100 kc is determined by the basic standard frequency signal being coupled to the frequency divider. When using the frequency calibrator with the calibrator set, the switch is positioned at 5 mc. The switch is used to connect the correct signal through the pulse shaper in all three positions. In the 5 mc and 1 mc positions, the switch also connects the 100-kc square-wave signal from plug-in unit 1114-P2 to 1114-P3.

b. Detailed Operation.

(1) *5 Mc position.*

(*a*) Terminals 6 and 5, segment Y, connect the 1114-P1 1-mc output signal from terminal 16 to amplifier Q901 of the pulse shaper.

(*b*) Terminals 1 and 12, segment X, connect the pulse shaper output

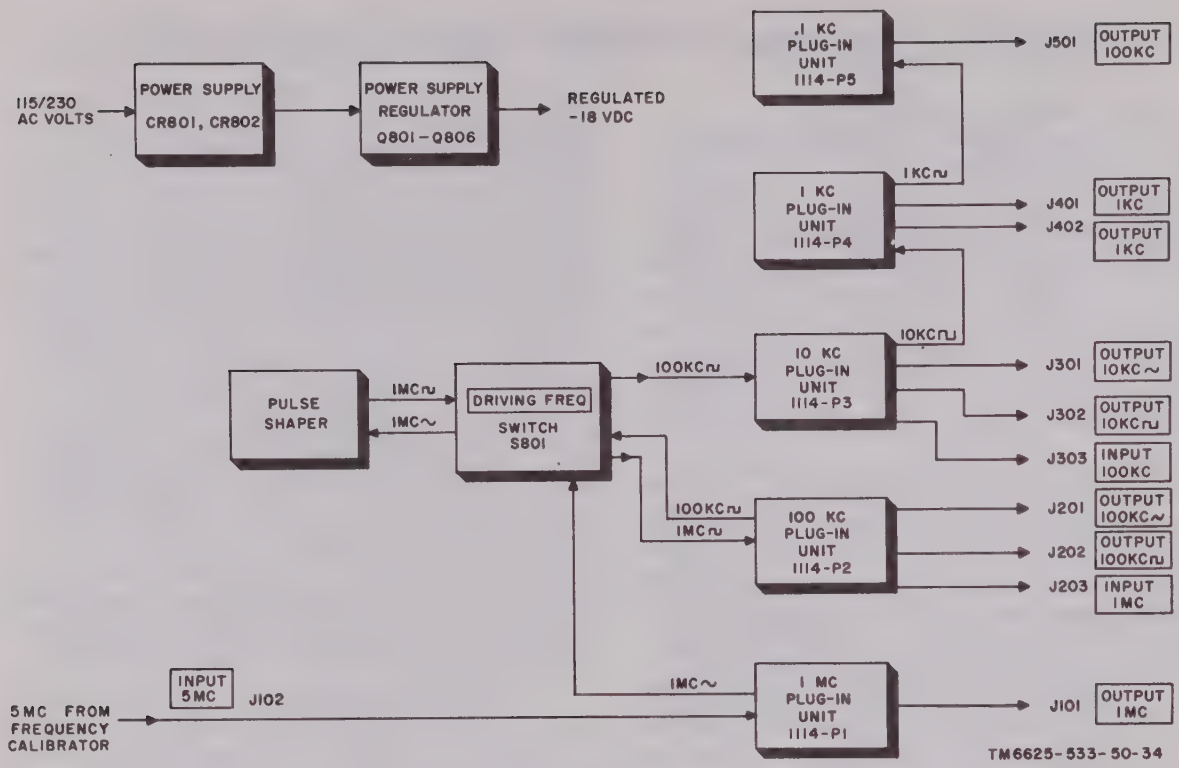


Figure 1–30. Frequency Divider CV–1517/URM–18A, block diagram.

signal, 1-mc square wave, to terminal 23, plug-in unit 1114-P2.

(*c*) Terminals 9 and 10, segment Z, connect the plug-in unit 1114-P2 output signal, 100-kc square-wave, to terminal 35, plug-in unit 1114-P3.

(2) *1 mc position.*

(*a*) Terminals 7 and 5, segment Y, connect the 1114-P2 1-mc output signal from terminal 21 to amplifier Q901 of the pulse shaper.

(*b*) Terminals 1 and 12, segment X, connect the pulse shaper output signal, 1-mc square-wave, to terminal 23, plug-in unit 1114-P2.

(*c*) Terminals 9 and 10, segment Z, connect the plug-in unit 1114-P2 output signal, 100-kc square-wave, to terminal 35, plug-in unit 1114-P3.

(3) *100 kc position.*

(*a*) Terminals 7 and 5, segment Y, connect the 1114-P2 100-kc output signal from terminal 21 to amplifier Q901 of the pulse shaper.

(*b*) Terminals 9 and 12, segments X and Z, connect the pulse shaper output signal, 100-kc square-wave, to terminal 35, plug-in unit 1114-P3.

1–30. Plug-In Unit 1114-P1, 1 Mc, Block Diagram
(fig. 1–32)

The 1-mc plug-in unit 1114-P1 is a regenerate divider that converts the frequency calibrator 5-mc input to a 1-mc sine-wave output that is applied to drive the lower frequency switching-type dividers. Its operation is such that a small amount of noise at 1 mc produces a small 4-mc signal, which is then mixed with the 5 mc input to increase the 1-mc output. This action is regenerative and may be compared to the starting of an oscillator. Signal paths and major functional sections of the unit are discussed in *a* through *c* below. For complete

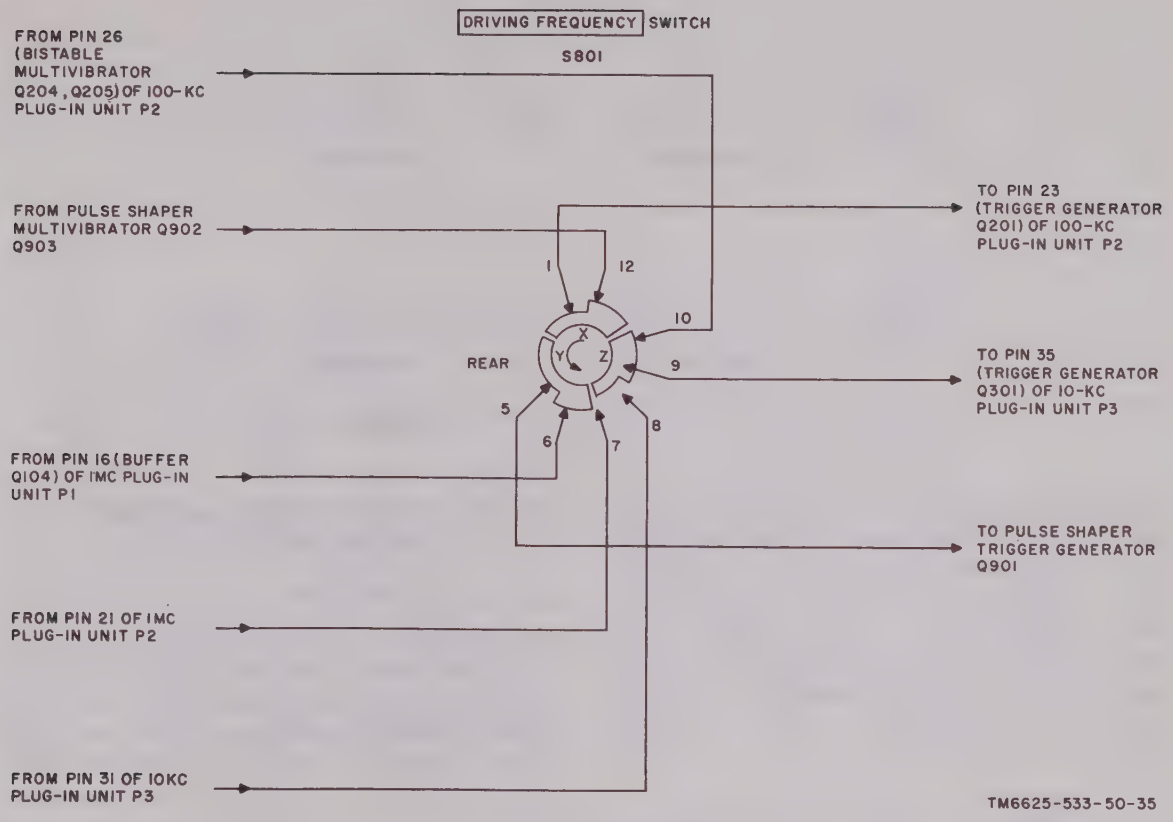


Figure 1–31. DRIVING FREQ switch S801 (CV–1518/URM–18A), schematic diagram.

circuit details, refer to the overall schematic diagram (fig. 4–6).

a. Mixer Q101. Mixer Q101 receives a 5-mc input from the frequency calibrator through J102 and a 4-mc input from multiplier Q103. The 1-mc output of the mixer is applied to multiplier Q103, amplifier Q102, and buffer amplifier Q104.

b. Multiplier Q103. Multiplier Q103 receives a 1-mc input from mixer Q101 and applies a 4-mc output back to mixer Q101.

c. Amplifier Q102 and Buffer Amplifier Q104.

(1) Amplifier Q102 receives the 1-mc output from mixer Q101 and supplies the amplified 1-mc sine wave at OUTPUT 1 MC J101.

(2) Buffer amplifier Q104 receives the 1-mc output from mixer Q101 and applies its 1-mc sine-wave output to the pulse shaper through S801.

1–31. Mixer Q101, Plug-In Unit 1114-P1 (fig. 1–33)

a. General. The 5-mc output from the frequency calibrator, together with the 4-mc output from multiplier Q103, is applied to mixer Q101. The output from Q101 is a 1-mc frequency difference signal that is coupled to the inputs of buffer Q104, amplifier Q102, and multiplier Q103.

b. Detailed Operation. The 5-mc output of the frequency calibrator is applied to the Q101 emitter through coupling capacitor C101 and the emitter bias network consisting of C102 and R101. The output circuit of the mixer is a 1-mc resonant tank circuit comprised of C106, C105, C103, C104, and L102. The 1-mc signal fed to amplifier Q102 and buffer Q104 is taken from the junction of C105 and C106. The 1-mc signal coupled to multiplier Q103 is taken from the junction of C103 and C104. The 4-mc output of multiplier Q103, is coupled directly back to the Q101 base. Fixed base

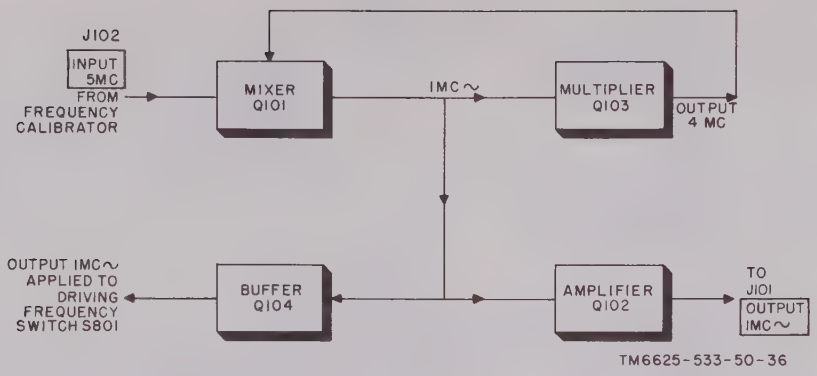


Figure 1–32. Plug-in unit 1114-P1, 1 mc (CV–1517/URM–18A), block diagram.

bias is provided by the voltage-divider network consisting R102 and R103. Inductor L101 is used as an emitter dc return and a blocking choke. Collector supply voltage is supplied by the −18-volt power supply regulator and applied through voltage-dropping resistor R104 with C107 as decoupling capacitor.

1–32. Amplifier Q102 and Buffer Q104, Plug-In Unit 1114-P1
(fig. 1–34)

a. General. The 1-MC output of Q101 is coupled to both amplifier Q102 and buffer Q104. The 1-MC signal coupled to amplifier Q102 is amplified and applied to OUTPUT 1-MC jack J101. Buffer Q104 isolates the buffer Q104 1-MC output to the pulse shaper through

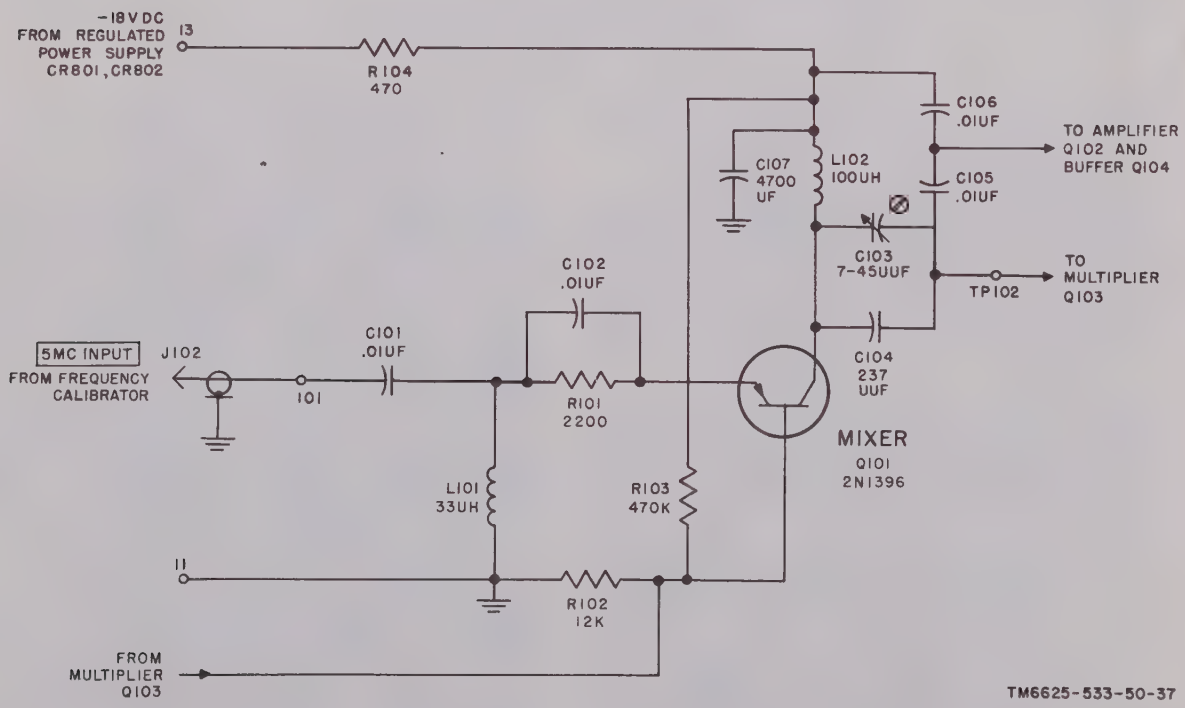


Figure 1–33. Mixer Q101, plug-in unit 1114-P1 (CV–1517/URM–18A), schematic diagram.

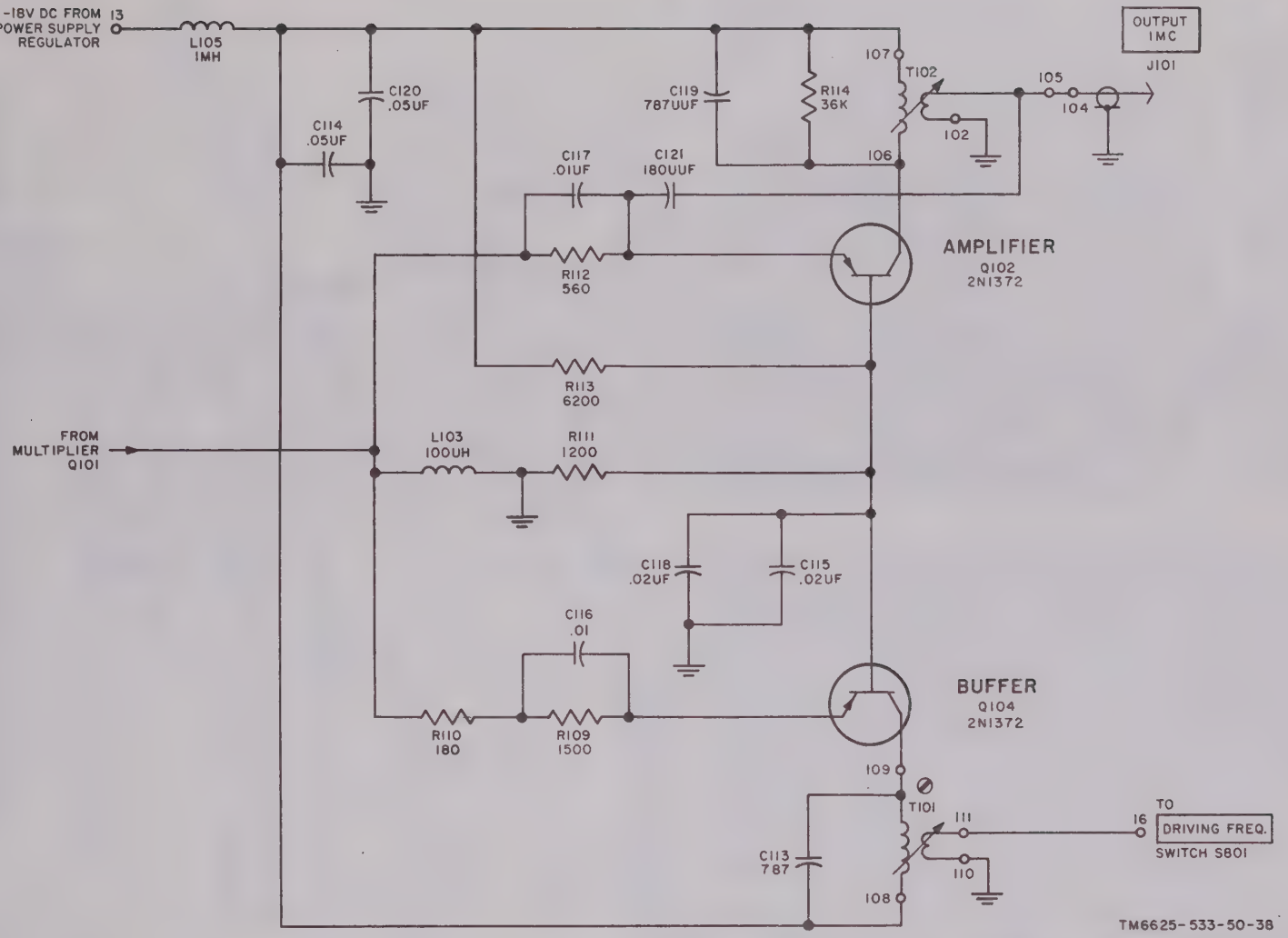


Figure 1–34. Amplifier Q102 and buffer Q104 plug-in unit 1114-P1, CV1517/URM–18A schematic diagram.

DRIVING FREQ switch S801 from mixer Q101 1-MC output.

b. Detailed Operation. The 1-MC output signal from multiplier Q101 is applied to Q102 emitter through the bias network consisting of resistor R112 and bypass capacitor C117. The Q102 collector output circuit is a 1-MC resonant tank circuit consisting of C119, the primary of T102, and R114. The tank circuit output is transformer-coupled to the secondary of T102 and then applied directly to OUTPUT 1 MC J101. Inverse feedback to the Q102 emitter from the secondary of T102 is through coupling capacitor C121. The 1-MC output signal from multiplier Q101 is also applied to the Q104 emitter through parasitic suppressor resistor R110, and the bias network consisting of R109 and bypass capacitor C116. The Q104 collector output circuit is a 1-MC resonant tank circuit consisting of C113 and the primary of T101. The output signal is transformer-coupled to the secondary of T101 and applied direct to DRIVING FREQ switch S801. Base bias for both Q102 and Q104 is supplied by the network consisting of voltage-dropping resistors R113 and R111. Emitter dc return, for Q102 and Q104 is through rf choke L103. Collector base bias supply voltage for both transistors is supplied by the −18-volt power supply regulator through rf choke L105, which is decoupled by C114 and C120.

1–33. Multiplier Q103, Plug-In Unit 1114-P1

(fig. 1–35)

a. General. The 1-MC output signal from mixer Q101 is applied to multiplier Q103. Due to circuitry action multiplier Q103 produces a 4-MC output that is coupled back to mixer Q101.

b. Detailed Operation. The 1-mc output from mixer Q101 is applied directly to the base of Q103. The Q103 output collector circuit is a resonant tank circuit tuned to the fourth harmonic at the 1-MC input signal. The 4-MC tank circuit consists of L104, C110, C109, and C111. The 4-MC output from the tank circuit is coupled direct to the mixer Q101 from the junction of C111 and C109. The Q103 emitter bias is provided by resistor R107 and bypass capacitor C108. The Q103 base bias is produced by the voltage-divider

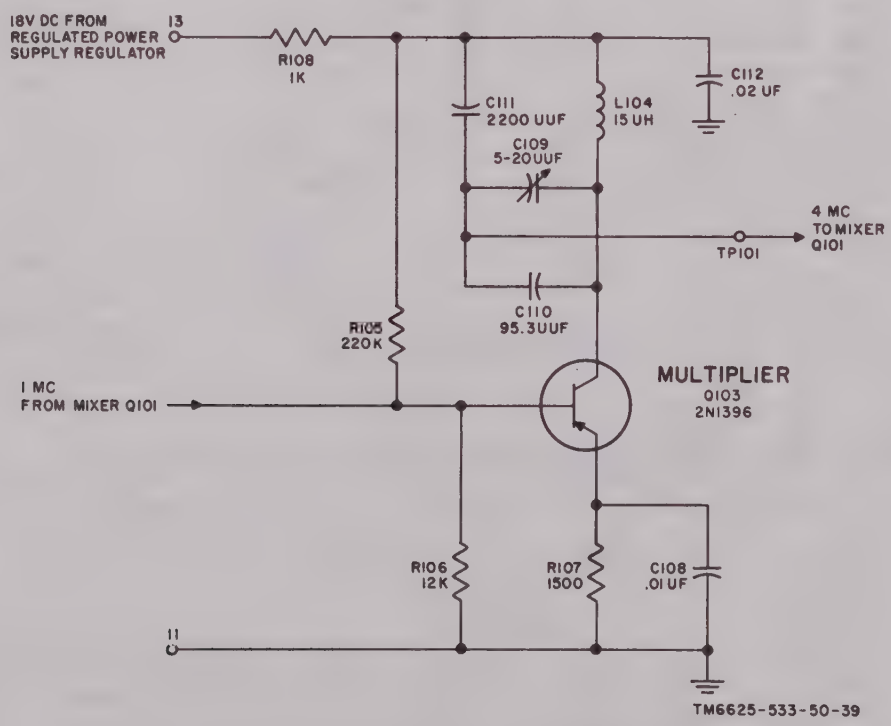


Figure 1–35. Multiplier Q103, plug-in unit 1114-P1 (CV–1517/URM–18A), schematic diagram.

network consisting of voltage-dropping resistors R105 and R106. The Q103 collector supply voltage is supplied by the —18-volt power supply regulator through voltage-dropping resistor R108 (decoupled by C112) and through resonant tank circuit inductor L104. The same voltage source supplied the base bias voltage.

1—34. Plug-In Unit 1114-P2, 100-kc, Block Diagram
(fig. 1–36)

The 100-kc plug-in unit 1114-P2 is a switching-type divider that is used to convert the input 1-MC signal to a 100-kc signal. The 1-MC square-wave input from DRIVING FREQ switch S801 is formed into short trigger pulses, which drive a monostable multivibrator so that it is reset at every fifth trigger pulse. The monostable multivibrator stage is followed by a bistable multivibrator, which divides by two. The resulting output is a square wave of one-tenth the input 1-MC frequency. The square-wave output of the bistable multivibrator is converter to a sine wave and amplified. Signal paths and major functional sections of the unit are shown in the block diagram (fig. 1–36) and are discussed in *a* through *f* below. For complete circuit details, refer to the overall schematic diagram (fig. 4–6).

a. Trigger Generator Q201. Trigger generator Q201 receives a 1-mc square-wave input from DRIVING FREQ switch S801 and converts the square-wave input to trigger pulses, which are applied to monostable multivibrator Q202 and Q203.

b. Monostable Multivibrator Q202 and Q203. Monostable multivibrator Q202 and Q203 receives the 1-mc trigger-pulse output of trigger generator Q201 and reacts to every fifth trigger pulse. The output is a 200-kc square wave used to activate bistable multivibrator Q204 and Q205.

c. Bistable Multivibrator Q204 and Q205. Bistable multivibrator Q204 and Q205 receives the 200-kc square-wave output of monostable multivibrator Q202 and Q203 and divides it by two. The resulting 100-kc square-wave outputs of the bistable multivibrator are applied to buffers Q206 and Q208 and to DRIVING FREQ switch S801.

d. Buffer Q206. Buffer Q206 receives a 100-kc square-wave output from bistable multivibrator Q204 and Q205 and converts it to a sine wave for application to amplifier Q207.

e. Amplifier Q207. Amplifier Q207 amplifies the 100-kc sine wave output of buffer Q206. The 100-kc sine wave output of amplifier Q207 is coupled to OUTPUT 100-kc ~ J201.

f. Buffer Q208. Buffer Q208 receives a 100-kc square-wave output from bistable multivibrator Q204 and Q205 that is 180° out of phase with the input of buffer Q206. The output of buffer Q208 is a 100-kc square wave in phase with the sine wave output at OUTPUT 100-kc J201. The square-wave output of buffer Q208 is coupled to the OUTPUT 100-kc ~ J202.

1—35. Trigger Generator Q201, Plug-In Unit 1114-P2
(fig. 1–37)

a. General. Trigger generator Q201 converts the 1-MC square-wave output of DRIVING FREQ switch S801 to trigger type pulses,

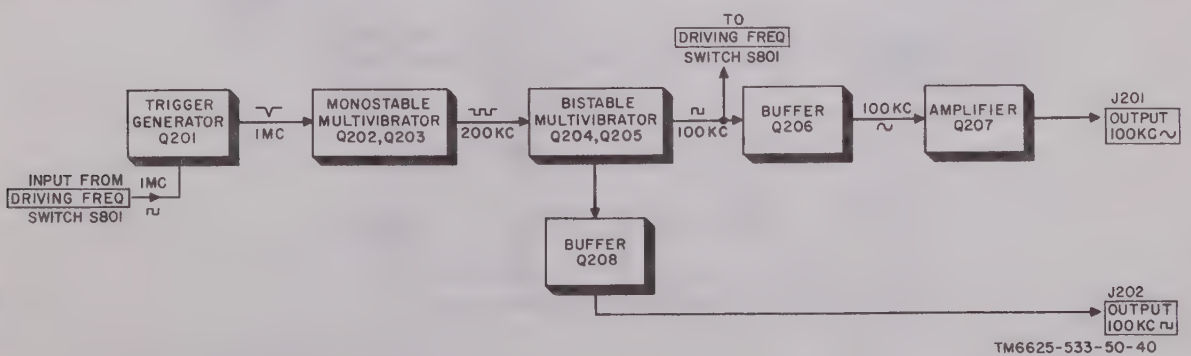


Figure 1–36. Plug-in unit 1114-P2, 100-kc, block diagram.

which are coupled to monostable multivibrator Q202 and Q203.

b. Detailed Operation. The 1-MC square-wave output from DRIVING FREQ switch S801 is applied to the base of Q201 through coupling capacitor C201. Only negative portions of the signal are applied to the base because of the clipping action of CR201. The time constant of C201 and R201 is such as to produce a sharp-spiked trigger pulse for each cycle of input signal to the base of Q201. The sharp-spiked pulses drive Q201 to produce the trigger-generator pulses in the output of Q201. When the Q201 base input signal activates collector current flow, a voltage drop occurs (a more positive potential) at the junction of R202 and CR202. This causes the anode of CR202 to become more positive than its cathode, causing an electron flow from the following stage through the diode. Emitter bias is provided by voltage-dropping resistor R203 and bypass capacitor C202. Collector supply voltage is supplied by the power supply regulator and applied through dropping resistor R202.

1–36. Monostable Multivibrator Q202 and Q203, Plug-In Unit 1114-P2 (fig. 1–38)

a. General. Monostable multivibrator Q202 and Q203 produces a 200-kc square-wave signal by using every fifth input trigger pulse from trigger generator Q201. The 200-kc square-wave signal is used to control the output frequency of bistable multivibrator or Q204 and Q205.

b. Detailed Operation. With no input applied, Q203 conducts and Q202 does not. Reverse emitter bias, developed by Q203 emitter-collector current through R205, is also applied to Q202. Forward base bias for Q202 is developed by the voltage-divider network consisting of R206 and R207 with C203 as bypass capacitor across R207. Forward base bias for Q203 is provided by variable resistor R208 and fixed resistor R209. Diode CR203 provides fixed-reverse emitter bias for Q203 when Q203 conducts. Resistor R208 is adjusted so that the forward bias applied to Q203 is an amount that can be overridden by a series of five positive pulses applied by the trigger generator. These pulses are applied to the base of Q203 by the charging of C204. When the base of Q203 becomes positive with respect to the emitter, the transistor ceases to conduct. Decreased current flow through Q203 causes the collector circuit to become more negative. Reduced current flow through Q203 emitter-collector circuit reduces the reverse-emitter bias of Q202 by lowering the voltage

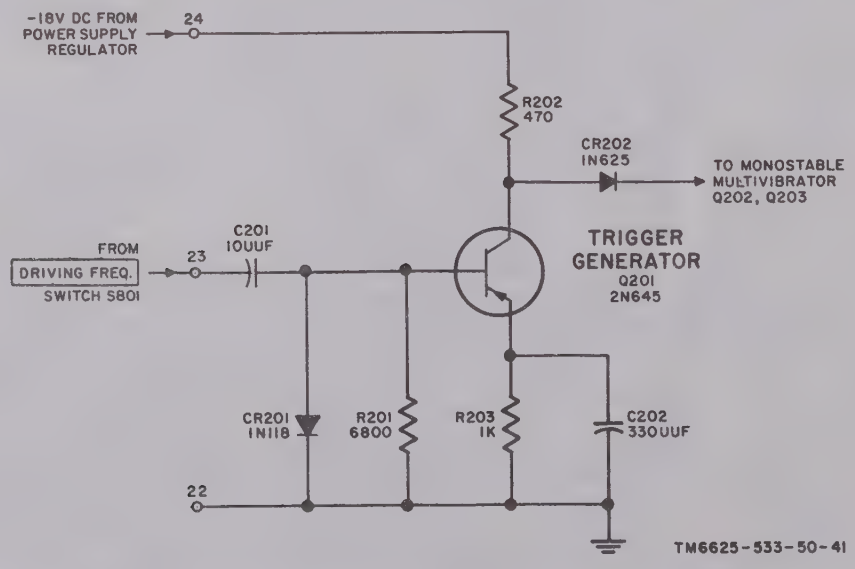


Figure 1–37. Trigger generator Q201, plug-in unit 1114-P2 (CV–1517/URM–18A), schematic diagram.

drop across R205. The net emitter-base bias is now a forward bias and Q202 conducts. As conduction occurs and current flows through the collector circuit of Q202, C204 discharges, allowing the forward-bias potential to be returned to the base of Q203. This allows Q203 to conduct again, causing the collector circuit to become more positive. A more negative potential appears on the cathode of CR203, causing current to flow through the diode. Increased current flow through R205 causes greater reverse-bias to be applied to Q202. The increased reverse-bias causes Q202 to stop conducting. The circuit action repeats itself during every five pulses of output signal from trigger generator Q201. The 200-kc output signal of monostable multivibrator Q202 and Q203 is taken from the junction of R210 and L202 and coupled to bistable multivibrator Q204 and Q205 through coupling capacitor C205. Collector supply voltage to Q202 is applied through voltage-dropping resistor R204 and rf choke L201. Collector supply voltage for Q203 is supplied through voltage-dropping resistor R210 and the ac blocking network rf choke L202 and R231.

1–37. Bistable Multivibrator Q204 and Q205, Plug-In Unit 1114-P2 (fig. 1–39)

a. General. The 200-kc negative pulse output from monostable multivibrator Q202 and Q203 is applied to the input of bistable multivibrator Q204 and Q205. The bistable multivibrator converts the 200-kc signal to two 100-kc signal outputs. One of the 100-kc output signals is coupled to buffer Q206 and to DRIVING FREQ switch S801. The other 100-kc signal is coupled to buffer Q208.

b. Detailed Operation. The cathodes of CR204 and CR205 are biased with −6 volts. The −6 volts is supplied from the power supply regulator through the voltage-divider network consisting of R219 and R220. The

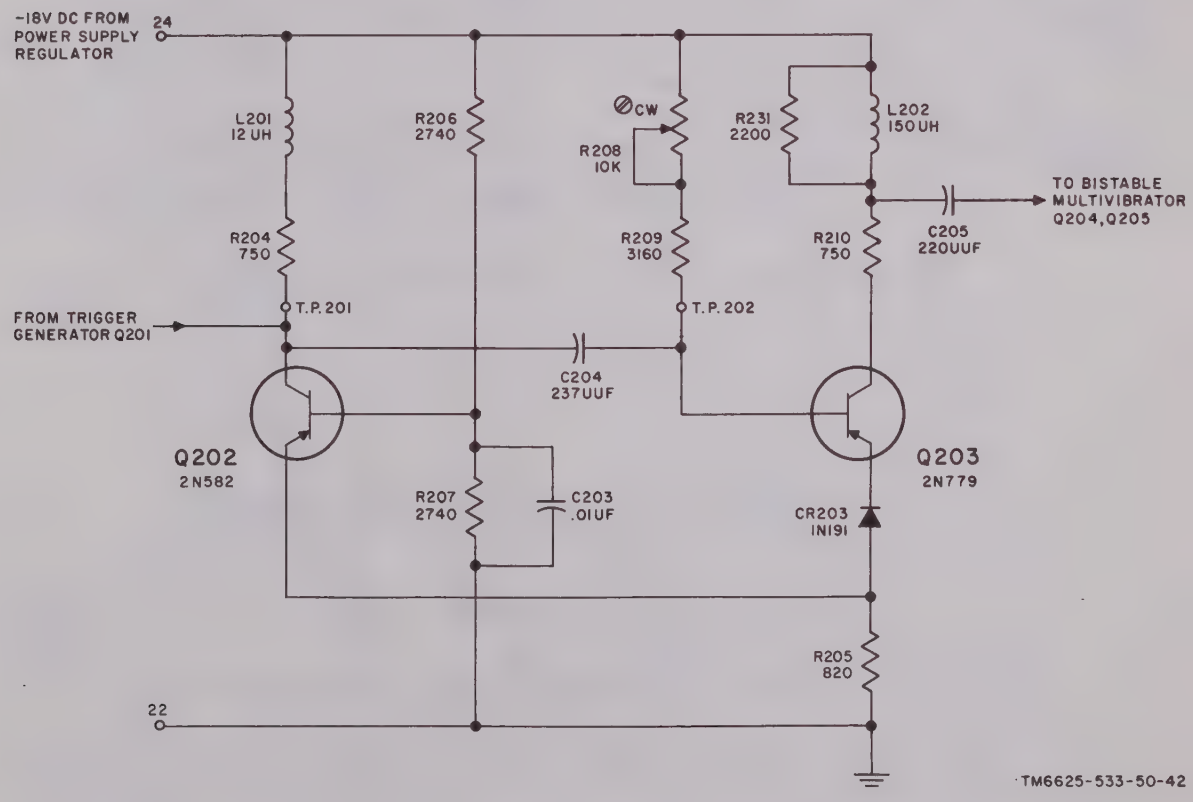


Figure 1–38. Monostable multivibrator Q202 and Q203, plug-in unit 1114-P2 (CV–1517/URM–18A), schematic diagram.

anodes of the diodes are also biased at a potential dependent upon which transistor is conducting. Assume Q204 is conducting and Q205 is not. With this condition existing, current flows through the collector-emitter circuit of Q204. Collector-emitter current flows through R214 with C214 as bypass capacitor, and causes an emitter-to-ground potential of approximately $-6\frac{1}{2}$ volts to be developed. The $-6\frac{1}{2}$ volts also reverse-biases emitter of Q205. When Q204 conducts, the Q204 collector voltage is more positive than during a nonconducting condition. This causes a small amount of current to flow through R216 and R212, and places a potential of approximately $-5\frac{1}{2}$ volts on the base of Q205 and the anode of CR205. This condition causes CR205 and the base of Q205 to be forward biased. The net emitter-base bias on Q205 is in a reverse condition because of R214 voltage drop. With Q205 not conducting all current flow through voltage-dropping resistor R217 is conducted through R215 and R213. The voltage level at the junction of R215 and R213, the base of Q204, is approximately -7 volts. This condition forward biases Q204, increasing conduction, and reverse biases CR204. When negative pulses are applied to the cathodes of CR204 and CR205, CR205 conducts heavily. Increased current flows through R216 and CR205, causes a more negative potential to be placed on the base of Q205 with respect to its emitter and removes the net reverse bias. This allows Q205 to start conducting and current begins to flow in the collector circuit, causing the voltage level at the collector of Q205 to become more positive. The increasing positive potential decreases the current flow through R213 and R215, applying a more positive potential, with respect to the emitter, to the base of Q204. This applies a net reverse bias and current through Q204 decreases, allowing the

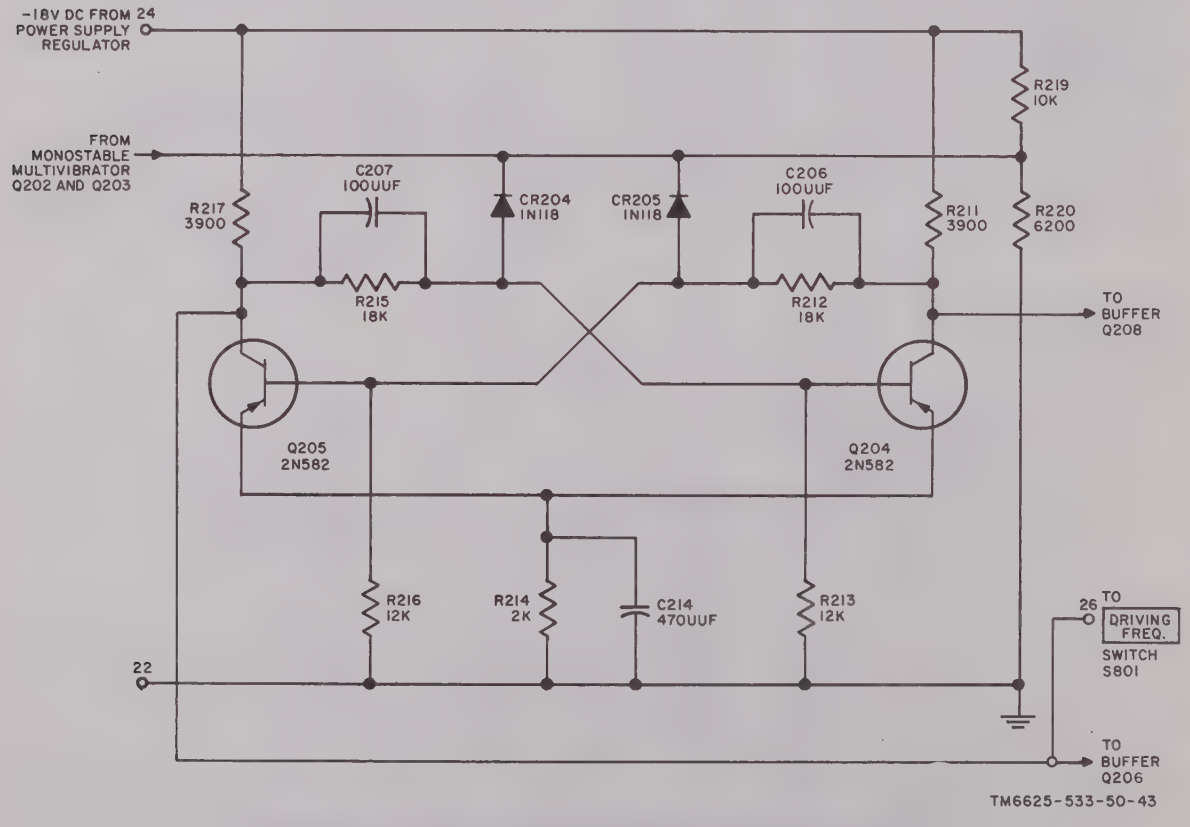


Figure 1–39. Bistable multivibrator Q204 and Q205, plug-in unit 1114-P2 (CV1517/URM–18A), schematic diagram.

potential at R211 and R212 to become more negative. The increased negative potential produces an increased current flow through R216 and R212, placing an increased forward bias on the base of Q205 and a reverse bias on CR205. The process continues until Q204 cuts off completely and Q205 conducts to saturation. When another negative pulse is received from the monostable multivibrator, the conduction and cutoff states reverse. This generates a single cycle of output signal from bistable multivibrator Q204 and Q205 for each two cycles of input signal from monostable multivibrator Q202 and Q203. Capacitors C207 and C206 are used to improve frequency response of the transistors. The output signal to buffer Q208 is coupled from the junction of R211 and R212. The output signal to buffer Q206 and DRIVING FREQ switch S801 is coupled from the junction of R217 and R215.

1–38. Buffer Q206, Plug-In Unit 1114-P2
(fig. 1–40)

a. General. Buffer Q206 provides isolation between amplifier Q207 and bistable multivibrator Q204 and Q205.

b. Detailed Operation. The 100-kc output signal of the bistable multivibrator is applied to the base of Q206 through current-limiting resistor R221. The output appears in the collector circuit, which is a resonant circuit tuned to 100-kc. This circuit consists of capacitor C208 and adjustable inductor L203. One end of the tank circuit is grounded. The 100-kc output signal applied to amplifier Q207 is taken off the center tap of L203. Emitter supply voltage is applied through voltage-dropping resistor R222.

1–39. Amplifier Q207, Plug-In Unit 1114-P2
(fig. 1–41)

a. General. The output of buffer Q206 is applied to amplifier Q207 and its amplified output is coupled to the OUTPUT 100-kc jack J201.

b. Detailed Operation. The output of buffer Q206 is applied to the emitter of Q207 through parasitic suppressor resistor R223 and the biasing network consisting of R224 and C209. The signal is amplified and appears in the collector circuit, which is a tuned tank circuit consisting of C212 and the primary of T201. The output is inductively coupled to the secondary of T201 and applied to OUTPUT 100-kc to J201. Collector supply voltage is applied through voltage-dropping resistor R227 and decoupled by capacitor C211. Base forward bias is provided by the voltage-divider consisting of R226 and R225. Capacitor C210 bypasses R225.

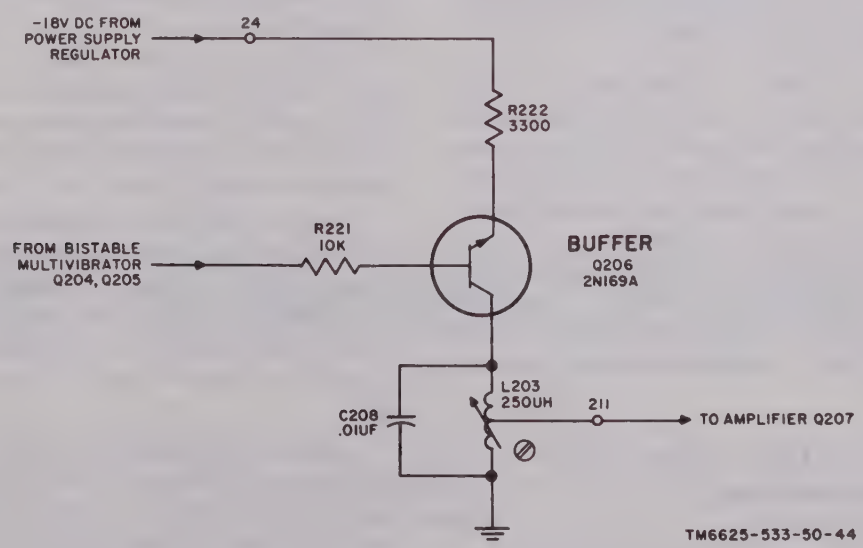


Figure 1–40. Buffer Q206, plug-in unit 1114-P2 (CV–1517/URM–18A), schematic diagram.

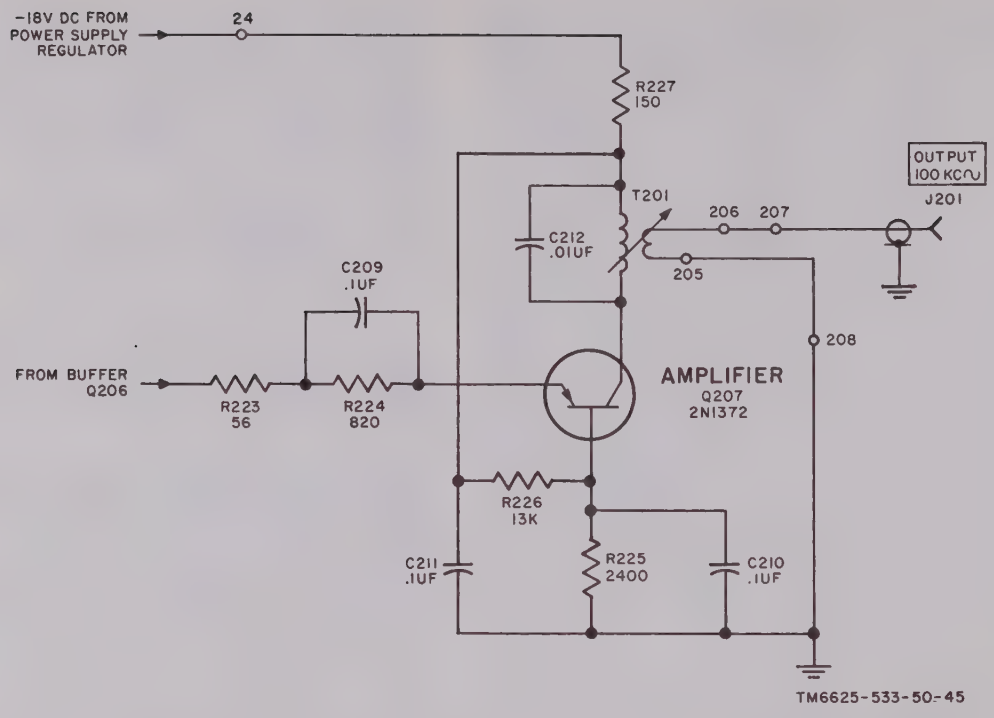


Figure 1–41. Amplifier Q207, plug-in unit 1114-P2 (CV–1517/URM–18A), schematic diagram.

1–40. Buffer Q208, Plug-In Unit 1114-P2

(fig. 1–42)

a. General. Buffer Q208 provides isolation between bistable multivibrator Q204 and Q205 and OUTPUT 100-kc ~ J202.

b. Detailed Operation. The 100-kc output signal bistable multivibrator Q204 and Q205 is applied to the base of Q208 through the series-limiting resistor R228. The 100-kc square-wave output is taken from the Q208 collector, which is grounded through R230, and coupled to OUTPUT 100-kc ~ J202 through coupling capacitor C213. Emitter voltage is supplied by the −18-volt power supply regulator and is applied through voltage-dropping resistor R229.

1–41. Plug-In Unit 1114-P3, 10-kc Block Diagram

(fig. 1–43)

The general operation of the 10-kc plug-in unit is similar to that of 100-kc plug-in unit 1114-P2 (para 1–34). Signal paths and major functional sections of the unit are shown in the block diagram (fig. 1–43) and are discussed in *a* through *f* below. For complete circuit details, refer to overall schematic diagram (fig. 4–6).

a. Trigger Generator Q301. Trigger generator Q301 receives a 100-kc from DRIVING FREQ switch S801 and converts square-wave input to trigger pulses, which are applied to monostable multivibrator Q302 and Q303.

b. Monostable Multivibrator Q302 and Q303. Monostable multivibrator Q302 and Q303 receives the 100-kc trigger-pulse output of trigger generator Q301 and reacts to every fifth trigger pulse. The output is a 20-kc square wave used to activate bistable multivibrator Q304 and Q305.

c. Bistable Multivibrator Q304 and Q305. Bistable multivibrator Q304 and Q305 receives the 20-kc square-wave output of monostable multivibrator Q302 and Q303 and divides it by two. The resulting 10-kc square-wave outputs of bistable multivibrator Q304 and Q305 are

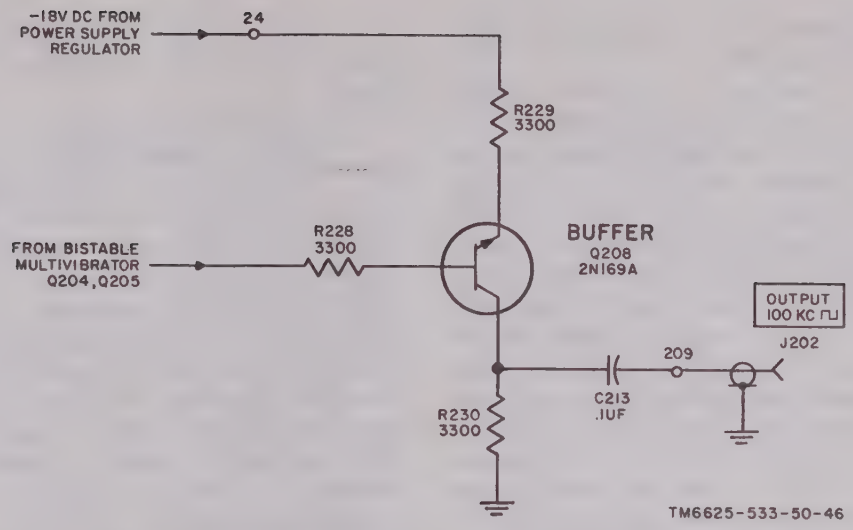


Figure 1–42. Buffer Q208, plug-in unit 1114-P2 (CV–1517/URM–18A), schematic diagram.

applied to emitter follower Q306, buffer Q308, and plug-in unit 1114-P4.

d. Emitter Follower Q306. Emitter follower Q306 couples the fundamental component of the 10-kc square wave from bistable multivibrator Q304 and Q305 to emitter follower Q307.

e. Emitter Follower Q307. Emitter follower Q307 receives the 10-kc sine-wave output of Q306 and provides the 10-kc output at OUTPUT 10-kc ~ J301.

f. Buffer Q308. Buffer Q308 receives a 10-kc square-wave output from bistable multivibrator Q304 and Q305 that is 180° out of phase with the input of emitter follower Q306. The 10-kc square-wave output of buffer Q308 is in phase with the sine-wave output of OUTPUT 10-kc ~ J301. Buffer Q308 output signal is coupled to OUTPUT 10-kc ~ J302.

1–42. Trigger Generator Q301, Plug-In Unit 1114-P3

(fig. 1–44)

a. General. The 100-kc square-wave output from DRIVING FREQ switch, S801 is applied to trigger generator Q301 and the output

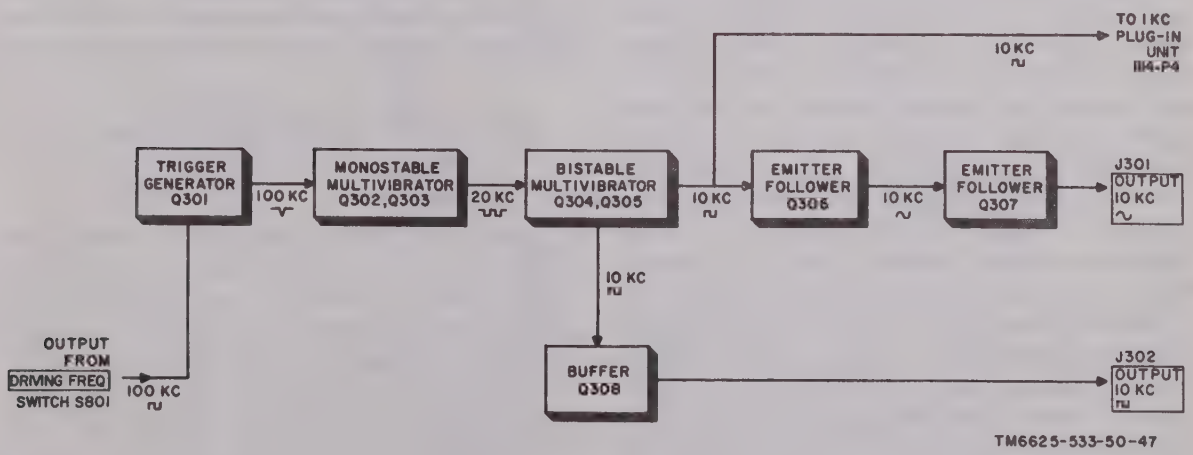


Figure 1–43. Plug-in unit 1114-P3, 10-kc (CV–1517/URM–18A), block diagram.

trigger-type pulses are fed to monostable multivibrator Q302 and Q303.

b. Detailed Operation. The 100-kc square-wave output from DRIVING FREQ switch S801 is applied to the base of Q301 through series-limiting resistor R331 and coupling capacitor C301. The negative portion of the square wave will cause Q301 to conduct current. The time constant of R331, R301, and C301 is such as to produce a sharp-spiked trigger pulse across R301 for each negative portion of the square-wave input signal. Each trigger pulse drives Q301 into conduction. When Q301 conducts, the voltage level at the junction of R303 and CR301 becomes less negative. This causes the anode of CR301 to become more positive than its cathode, therefore causing current to flow through the diode from monostable multivibrator Q302 and Q303. Collector supply voltage is applied through voltage-dropping resistor R303. Emitter bias is provided by R302, with C302 as bypass capacitor.

1–43. Monostable Multivibrator Q302 and Q303, Plug-In Unit 1114-P3 (fig. 1–45)

a. General. Monostable multivibrator Q302 and Q303 produces a 20-kc square-wave signal by using every fifth input trigger pulse from trigger generator Q301. The 20-kc square-wave signal is used to control the output frequency of bistable multivibrator Q304 and Q305.

b. Detailed Operation. With no input applied, Q303 conducts current and Q302 does not. Emitter voltage is developed by Q303 current flowing through R305. The potential developed by this action is applied as reverse bias to the emitter of Q302. Forward base bias for Q302 is developed by the voltage-divider network consisting of R306 and R307, with C304 as bypass capacitor across R307. Forward base bias for Q303 is provided by variable resistors R308 and fixed resistor R309. Variable resistor R308 is adjusted so that the forward-bias potential applied to Q303 is an amount that can be overcome by a series of five positive pulses applied by trigger generator Q301. These pulses are applied by the charging action of C303. When the base of Q303 becomes positive with respect to it's emitter, the transistor ceases to conduct. As current ceases to flow in the emitter circuit, the voltage drop across R305 becomes less negative. This process continues until the emitter of Q302 becomes more positive than its base, causing it to conduct. Current flow through the collector circuit of Q302 causes C303 to discharge and then recharge in the opposite polarity. This causes Q303 to become forward biased again,

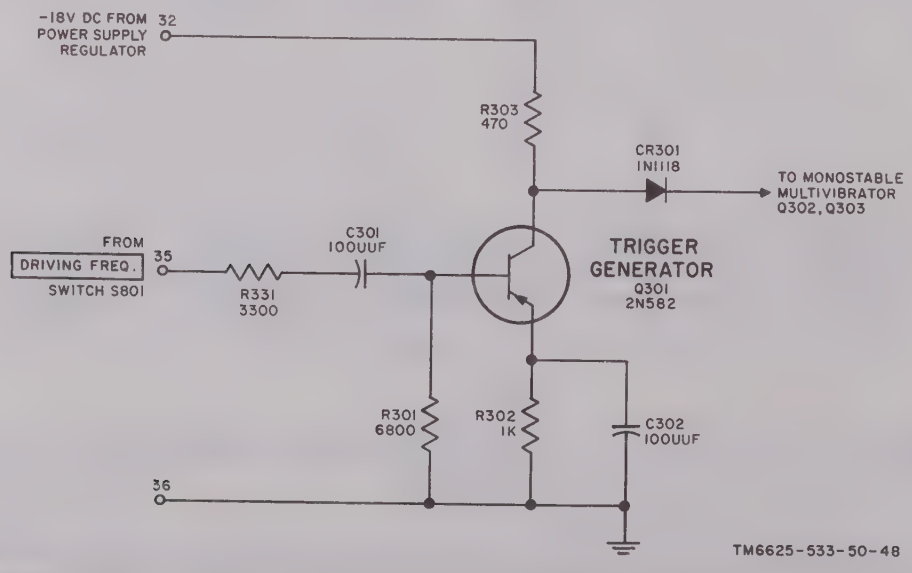


Figure 1–44. Trigger generator Q301, plug-in unit 1114-P3 (CV–1517/URM–18A), schematic diagram.

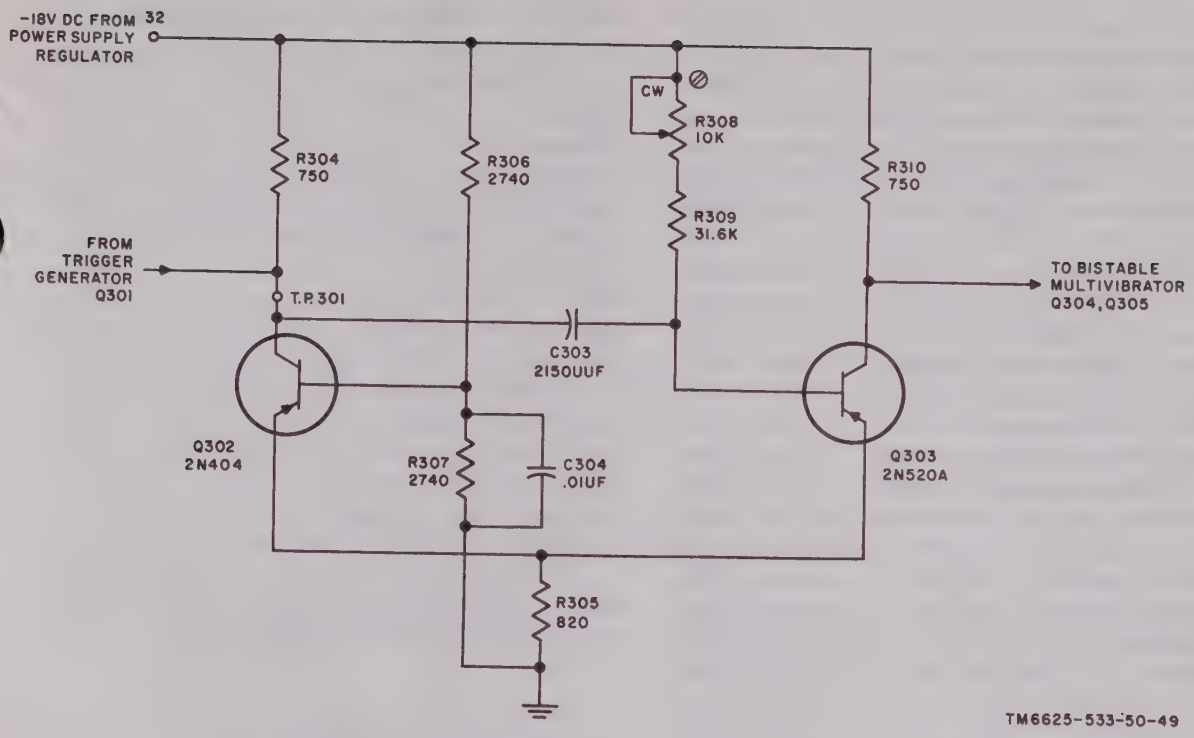


Figure 1–45. Monostable multivibrator Q302 and Q303, plug-in unit 1114-P3 (CV–1517/URM–18A), schematic diagram.

allowing it to conduct. The conduction of Q303 causes a greater voltage drop to occur across R305 this in turn creates a net reverse bias on the emitter-base circuit of Q302, which causes Q302 to stop conducting. This stable condition exists until the next series of five pulses from trigger generator Q301 overrides the forward bias on Q303. Collector supply voltage is applied to Q302 through voltage-dropping resistor R304 and to Q303 through voltage-dropping resistor R310.

1–44. Bistable Multivibrator Q304 and Q305, Plug-In Unit 1114-P3 (fig. 1–46)

a. General. The 20-kc negative pulse output from monostable multivibrator Q302 and Q303 is applied to the input of bistable multivibrator Q304 and Q305. Bistable multivibrator Q304 and Q305 converts the 20-kc signal to two 10-kc signal outputs. One of the 10-kc output signals is coupled to emitter follower Q306 and to plug-in unit 1114-P4. The other 10-kc signal is coupled to buffer Q308.

b. Detailed Operation. The cathodes of CR303 and CR302 are biased at −5 volts. The −5-volt level is supplied by the power supply regulator through the voltage-divider network consisting of R318 and R319. The anodes of the diodes are biased at a potential dependent upon which transistor is conducting. Assume Q304 is conducting and Q305 is not. With this condition existing, current flows through the collector-emitter circuit of Q304. The same collector-emitter current flows through R316 with C308 as bypass capacitor and causes an emitter-to-ground potential of approximately $-6\frac{1}{2}$ volts. The $-6\frac{1}{2}$ volts also reverse-biases the emitter of Q305. When Q304 conducts the Q304 collector voltage is more positive than during a nonconducting condition. This causes a small amount of current to flow through R317 and R313, and places a potential of approximately −5 volts on the base of Q305 and the anode of CR303. This condition causes CR303 anode to be at a potential balance with its cathode and Q305 to be reverse biased. With Q305 cutoff and no collector current flow-

ing, the potential at the junction of R315 and R314 is approximately equal to the collector supply voltage. This causes maximum current to flow through R312 and R314, placing a potential of approximately $-7\frac{1}{2}$ volts on the base of Q304. The net result is that Q304 is forward biased and in full conduction while Q305 is reverse biased and nonconducting. When negative pulses are applied to the cathodes of CR303 and CR302 through C305, the potential balance of CR303 is upset. Current flows through CR305 and R317, causing a more negative potential to be placed on the base of Q305. This removes the reverse bias and allows Q305 to conduct current. Current flow in the collector-emitter circuit of Q305 causes the voltage level at the junction of R315 and R314 to become more positive. The increased positive potential reduces the current flow through R312 and R314, with the result that the potential at the base of Q304 becomes less negative. This causes Q304 to be cut off and allows the potential at the junction of R311 and R313 to approach the collector supply voltage valve. This produces an increase current flow through R317 and R313, thereby placing an increased forward bias on the base of Q305 and a reverse bias on CR303. This process continues until Q304 cuts off completely, with CR302 at a potential balance and Q305 conducts to saturation. When another negative pulse is received from the monostable multivibrator, the conduction and cutoff states are reversed. This generates a single cycle of output signal from bistable multivibrator Q304 and Q305 for each two cycles of input signal from monostable multivibrator Q302 and Q303. Capacitors C306 and C307 are used to improve the frequency response between the two transistors. Output to emitter follower Q306 and the plug-in unit 1114-P4 is taken at the collector of Q305. The output to buffer Q308 is taken at the collector of Q304.

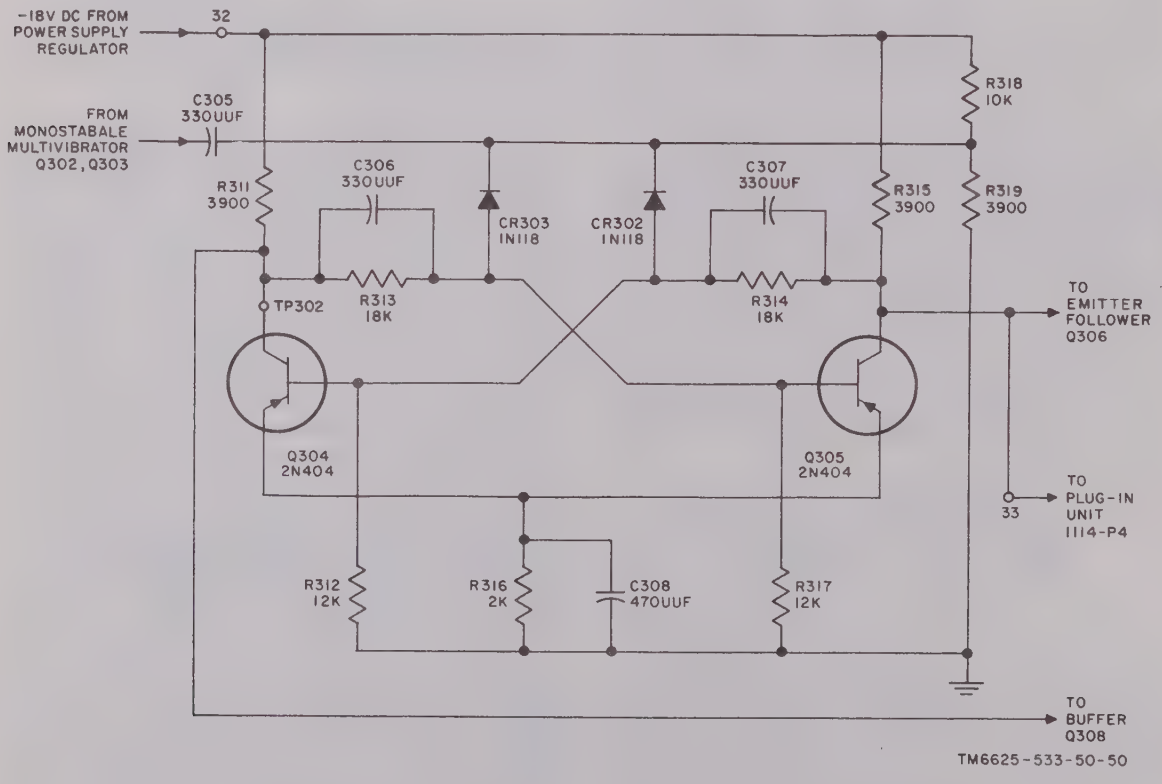


Figure 1–46. Bistable multivibrator Q304 and Q305, plug-in unit 1114-P3 (CV–1517/URM–18A), schematic diagram.

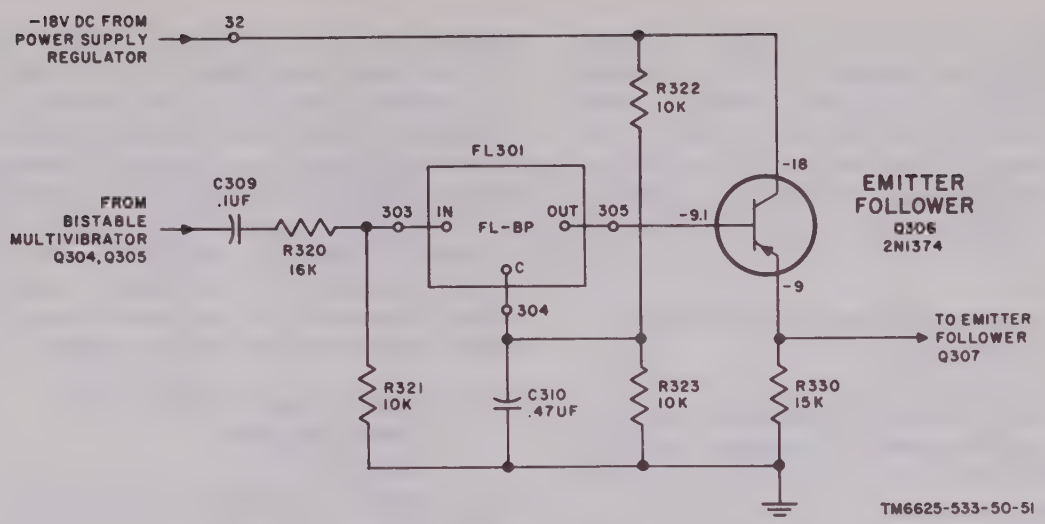


Figure 1–47. Amplifier Q306, plug-in unit 1114-P3 (CV–1517/URM–18A), schematic diagram.

1–45. Emitter Follower Q306, Plug-In Unit 1114-P3

(fig. 1–47)

a. General. The square-wave output of bistable multivibrator Q304 and Q305 is applied to emitter follower Q306 to change the square wave to a sine wave. The output is coupled to emitter follower Q307.

b. Detailed Operation. The 10-kc square-wave output from bistable multivibrator Q304 and Q305 is coupled to 10-kc bandpass filter, FL301 through coupling capacitor C309 and an impedance-matching network consisting of R320 and R321. The bandpass filter selects the fundamental frequency of the square wave to provide an equivelent sine wave of the same frequency. The output of the bandpass filter is coupled direct to the base of Q306. The out-

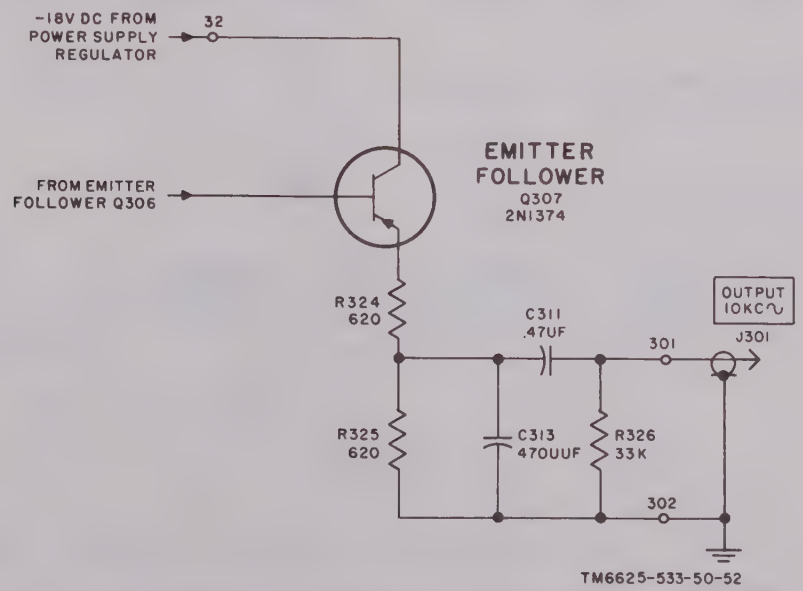


Figure 1–48. Emitter follower Q307, plug-in unit 1114-P3, schematic diagram.

put of Q306, the emitter circuit, is developed across R330 and coupled directly to emitter follower Q307. The Q306 collector supply voltage is applied directly from the power supply regulator. Base bias is developed by the voltage-divider network consisting of R322 and R323, with C310 as bypass capacitor across R323.

1–46. Emitter Follower Q307, Plug-In Unit 1114-P3 (fig. 1–48)

a. General. The 10-kc sine-wave output of emitter follower Q306 is applied to Q307 and its low-impedance output is applied to OUTPUT 10-kc ∼ J301.

b. Detailed Operation. The output of emitter follower Q306 is coupled directly to the base of Q307. The output of Q307, the emitter circuit, is applied across the network of R324 and R325 with C313 as a high-frequency bypass. The output signal is coupled to OUTPUT 10-kc ∼ J301 through coupling capacitor C311 with R326 as an impedance-matching resistor. The collector is connected directly to the power supply regulator for collector voltage.

1–47. Buffer, Q308, Plug-In Unit 1114-P3 (fig. 1–49)

a. General. Buffer Q308 isolates the 10-kc square-wave output of bistable multivibrator Q304 and Q305 from output 10 kc ∼ J302.

b. Detailed Operation. The output of bistable multivibrator Q304 and Q305 applied to the base of Q308 through parasitic suppressor resistor R327. The output, in the collector circuit, is taken across grounded resistor R329. The signal is coupled to output 10 kc ∼ J302 through coupling capacitor C312. The Q308 emitter is connected to the power supply regulator through voltage-dropping resistor R328.

1–48. Plug-In Unit 1114-P4, 1 Kc, Block Diagram (fig. 1–50)

The general operation of the 1 kc plug-in unit is similar to that of the 100-kc plug-in unit 1114-P2 (para 1–34). Signal paths and major functional sections of the unit are shown in the block diagram (fig. 1–50) and are discussed in *a* through *e* below. For complete circuit details, refer to the overall schematic diagram (fig. 4–6).

a. Trigger Generator Q401. Trigger generator Q401 receives a 10-kc square-wave input from 10-kc plug-in unit 1114-P3 and converts the square-wave input to trigger pulses, which are applied to monostable multivibrator Q402 and Q403.

b. Monostable Multivibrator Q402 and Q403. Monostable multivibrator Q402 and Q403 re-

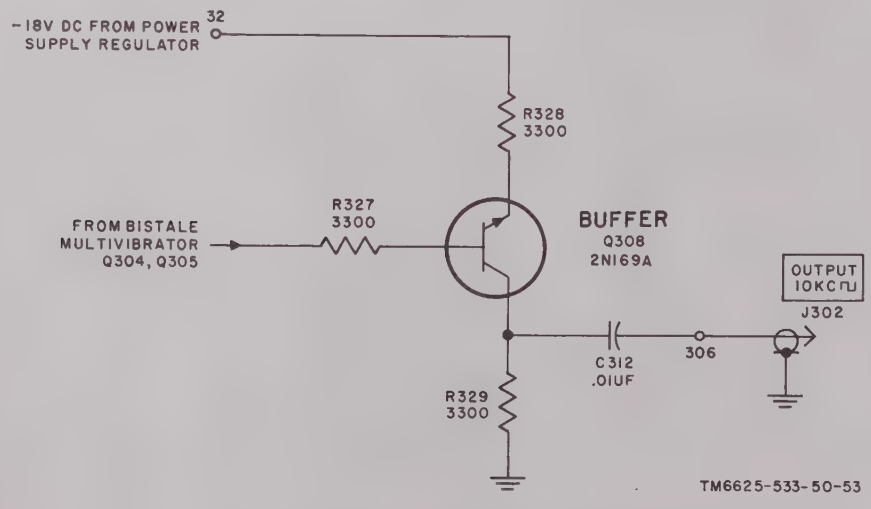


Figure 1–49. Buffer Q308, plug-in unit 1114-P3 CV–1517/URM–18A, schematic diagram.

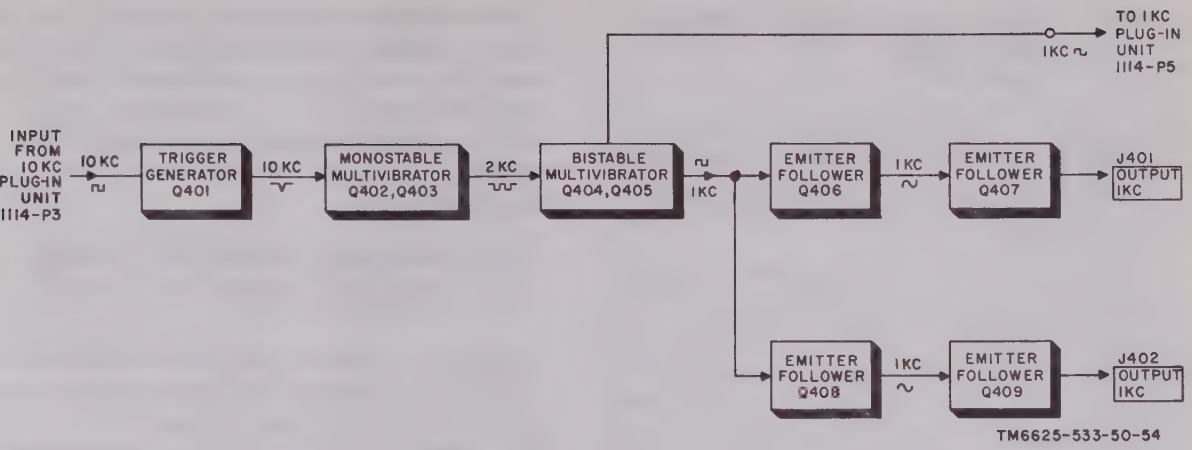


Figure 1–50. Plug-in unit 1114-P4, 1 kc CV–1517/URM–18A block diagram.

ceives the 10-kc trigger-pulse output of trigger generator Q401 and reacts to every fifth trigger pulse. The output is a 2-kc square wave used to activate bistable multivibrator Q404 and Q405.

c. Bistable Multivibrator Q404 and Q405. Bistable multivibrator Q404 and Q405 receives the 2-kc square-wave output of monostable multivibrator Q402 and Q403 and divides it by two. The resulting 1-kc square-wave outputs of bistable multivibrator Q404 and Q405 are applied to emitter followers Q406 and Q408 and to 0.1-kc plug-in unit 1114-P5.

d. Emitter Followers Q406 and Q408. Emitter followers Q406 and Q408 couple the fundamental component of the 1-kc square wave from bistable multivibrator Q404 and Q405 to emitter followers Q407 and Q409.

e. Emitter Followers Q407 and Q409. Emitter follower Q407 couples emitter follower Q406 1-kc sine-wave output to output 1 kc J401. Emitter follower Q409 couples emitter follower Q408 1-kc sine-wave output to OUTPUT 1-kc J402.

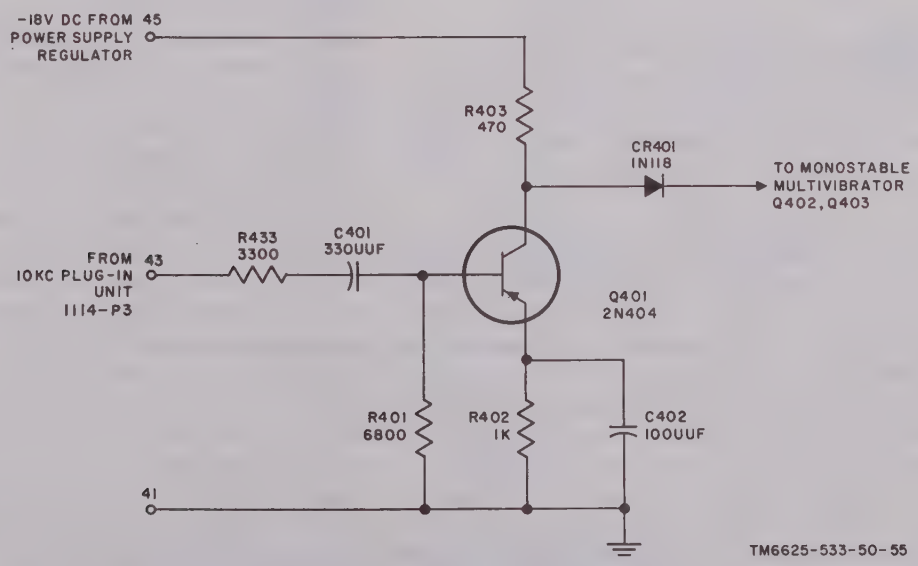


Figure 1–51. Trigger generator Q401 plug-in unit 1114-P4, CV–1517/URM–18A, schematic diagram.

1–49. Trigger Generator Q401, Plug-In Unit 1114-P4
(fig. 1–51)

a. General. The 10-kc square wave output from 10-kc plug-in unit 1114-P3 is applied to trigger generator Q401 and the output trigger-type pulses are fed to monostable multivibrator Q402 and Q403.

b. Detailed Operation. The 10-kc square-wave output from plug-in unit 1114-P3 is applied to the base of Q401 through series-limiting resistor R433 and coupling capacitor C401. The negative portion of the square wave will cause Q401 to conduct current. The time constant of R433, C401, and R401, is such as to produce sharp-spiked trigger pulses across R401 for each negative portion of the square-wave input signal. Each trigger pulse-drives Q401 into conduction. When Q401 conducts the voltage level at the junction of R403 and CR401 becomes less negative. This causes the anode of CR401 to become more positive than its cathode, causing current to flow through the diode from monostable multivibrator Q402 and Q403. Collector supply voltage is applied through voltage-dropping resistor R403. Emitter bias is provided by R402 with C402 as bypass capacitor.

1–50. Monostable Multivibrator Q402 and Q403, Plug-In Unit 1114-P4
(fig. 1–52)

a. General. Monostable multivibrator Q402 and Q403 produces a 2-kc square-wave signal by using every fifth input trigger pulse from trigger generator Q401. The 2-kc square-wave signal is used to control the output frequency of bistable multivibrator Q404 and Q405.

b. Detailed Operation. The operation of this circuit is the same as that described in paragraph 1–43 except for the frequencies of the input and output signals.

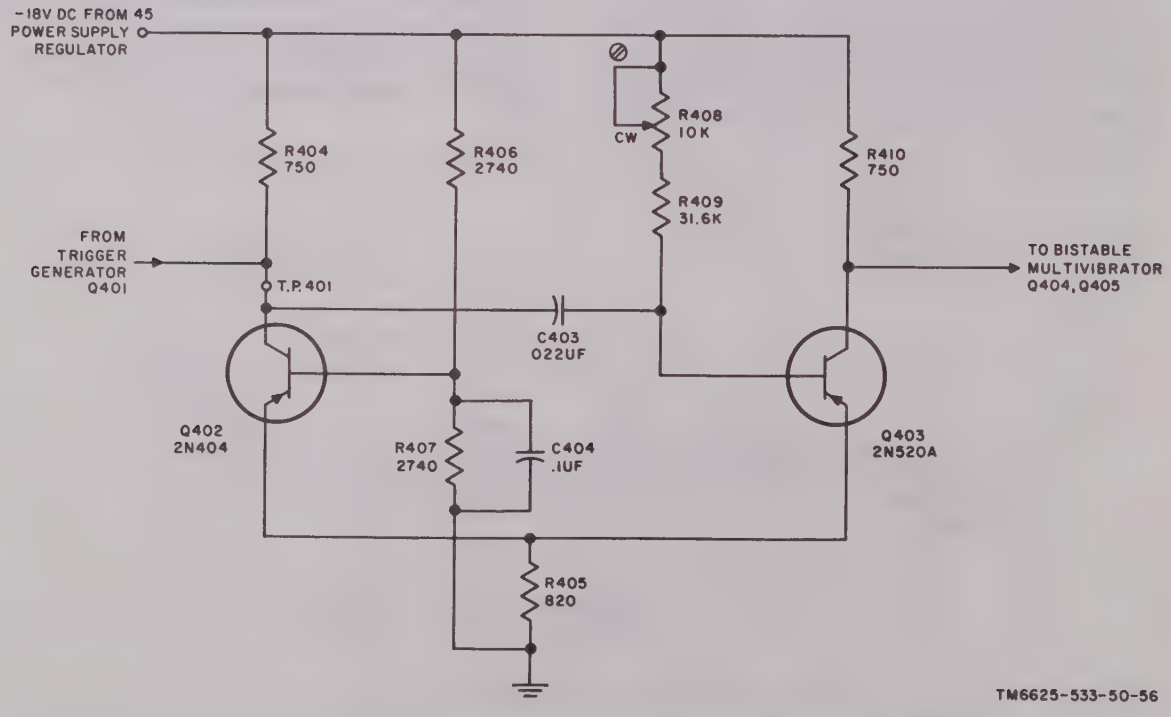


Figure 1–52. Monostable multivibrator Q402 and Q403, plug-in unit 1114-P4, CV–1517/URM–18A, schematic diagram.

1–51. Bistable Multivibrator Q404 and Q405, Plug-In Unit 1114-P4
(fig. 1–53)

a. General. The 2 kc square-wave output from monostable multivibrator Q402 and Q403 is applied to the input of bistable multivibrator Q404 and Q405. Two 1-kc square-wave output signals are generated. One output signal is coupled to both emitter followers Q406 and Q408. The other output signal is coupled to plug-in unit 1114-P5.

b. Detailed Operation. The cathodes of CR403 and CR402 are biased with −5.6 volts. The −5.6 volts is supplied from the power supply regulator through the voltage-divider network consisting of R418 and R419. The anodes of these diodes are also biased at a potential dependent upon which transistor is conducting. Assume Q404 is conducting and Q405 is not. With this condition existing, current flows through the collector-emitter circuits of Q404. Collection-emitter current flows through R416, with C408 as bypass capacitor, and causes an emitter-to-ground potential of approximately −6.5 volts. The −6.5 volts also reverse biases the emitter of Q405. When Q404 conducts, the Q404 collector voltage is more positive than during a nonconducting condition. This causes a small amount of current to flow through R417 and R413, and places a potential of approximately −6 volts on the base of Q405 and the anode of CR403. This condition causes CR403 anode to be at a potential balance with its cathode and Q405 to be reverse biased. With Q405 not conducting and no collector current flowing, the potential at the junction of R415 and R414 is approximately equal to the collector supply voltage. This causes a maximum current to flow through R414 and R412 and generates a potential of approximately −7 volts at the base of Q404. The net result is that Q404 is forward biased and in full conduction while Q405 is reversed biased and nonconducting. When negative pulses are applied to the cathodes of CR403 and CR402 through C405, the potential balance of CR403 is upset and current flows through R417 and CR403. This causes a more negative potential to be placed on the base of Q405, removing the reverse bias. Removing the reverse bias allows Q405 to conduct and current begins to flow in the collector circuit, causing the voltage level at the junction of R415 and R414 to become less negative. The decreasing potential at this point decreases the current flow through R412 and R414, making the base voltage of Q404 positive with respect to its emitter. As Q404 ceases to conduct, the potential at the junction of R411 and R413 approaches the level of the collector supply voltage. This produces an increase current flow through R417 and R413, thereby increasing the forward bias on the base of Q405 and reverse biases CR403. This process continues until Q404 cuts off completely with CR402 at a potential balance and Q405 conducts to saturation. When another negative pulse is received from the monostable multivibrator the conduction and cutoff states are reversed. This generates a single cycle of output signal from bistable multivibrator Q404 and Q405 for each two cycles of input signal from monostable multivibrator Q402 and Q403. Capacitors C406 and C407 are used to improve frequency response of the two transistors. The 1-kc square-wave output signal applied to emitter followers Q406 and Q408 is taken at the collector of Q405. The output to 100 cps plug-in unit 1114-P5 is applied through series-limiting resistor R430 from the collector of Q404.

1–52. Emitter Follower Q406 and Q408, Plug-In Unit 1114-P4
(fig. 1–54)

a. General. The 1-kc square-wave output of bistable multivibrator Q404 and Q405 is applied to emitter followers Q406 and Q408 and the 1-kc sine-wave output is fed to emitter followers Q407 and Q409.

b. Detailed Operation. The 1-kc square-wave output from bistable multivibrator Q404 and Q405 is applied to the input of 1-kc bandpass filter FL401 through coupling capacitor C409 and an impedance-matching network consisting of R420 and R421. Bandpass filter FL401 selects the fundamental frequency of the square wave to provide an equivalent sine wave of the same frequency. The output of FL401 is connected directly to the bases of Q406 and Q408. The output of Q406 is developed across R431 and coupled directly to emitter follower Q407. The output of Q408 is

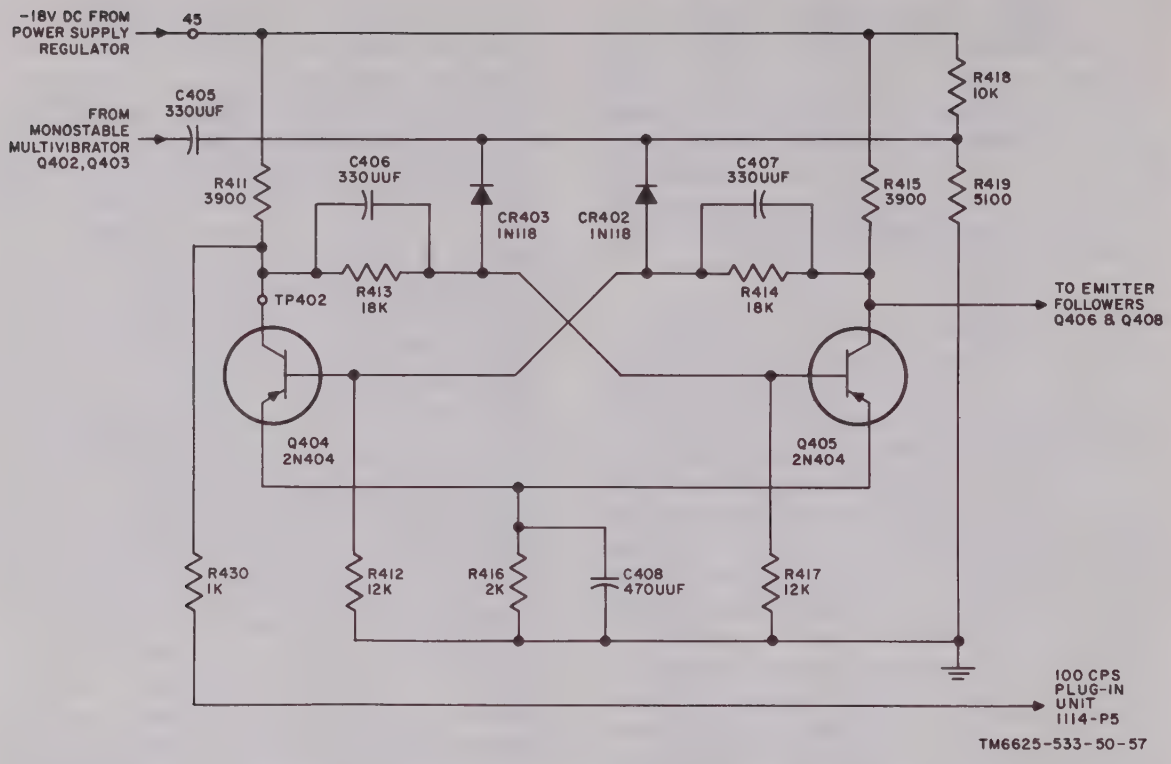


Figure 1–53. Bistable multivibrator Q404 and Q405 plug-in unit 1114-P4, CV–1517/URM–18A, schematic diagram.

developed across R432 and coupled directly to emitter follower Q409. Base forward bias for Q406 and Q408 is developed by the voltage-divider network consisting of R422 and R423 with C410 as bypass capacitor across R423.

1–53. Emitter Follower Q407, Plug-In Unit 1114-P4
(fig. 1–55)

a. General. The 1-kc sine-wave output of emitter follower Q406 is applied to emitter follower Q407 and the low-impedance output of Q407 is applied to OUTPUT 1KC J401.

b. Detailed Operation. The 1-kc sine-wave output of emitter follower Q406 is coupled directly to the base of Q407. The total output signal in the Q407 emitter circuit is developed across the voltage divider consisting of R424 and R425. That portion of the Q407 output signal across R425 is coupled to output 1 kc J401 through coupling capacitor C411. Resistor R428 is used as an impedance-matching resistor. The collector of Q407 is connected directly to the power supply regulator.

1–54. Emitter Follower Q409, Plug-In Unit 1114-P4
(fig. 1–56)

a. General. The 1-kc sine-wave output of emitter follower Q408 is applied to emitter follower Q409 and the low-impedance output of Q409 is applied to OUTPUT 1 KC J402.

b. Detailed Operation. The 1-kc sine-wave output of emitter folower Q408 is coupled directly to the base of Q409. The total output signal in the Q409 emitter circuit is developed across the network consisting of R426 and R427. That portion of the output signal across R427 is coupled to output 1 kc J402 through coupling capacitor C412. Resistor R429 is used as an impedance-matching resistor. The Q409 collector is connected directly to the power supply regulator.

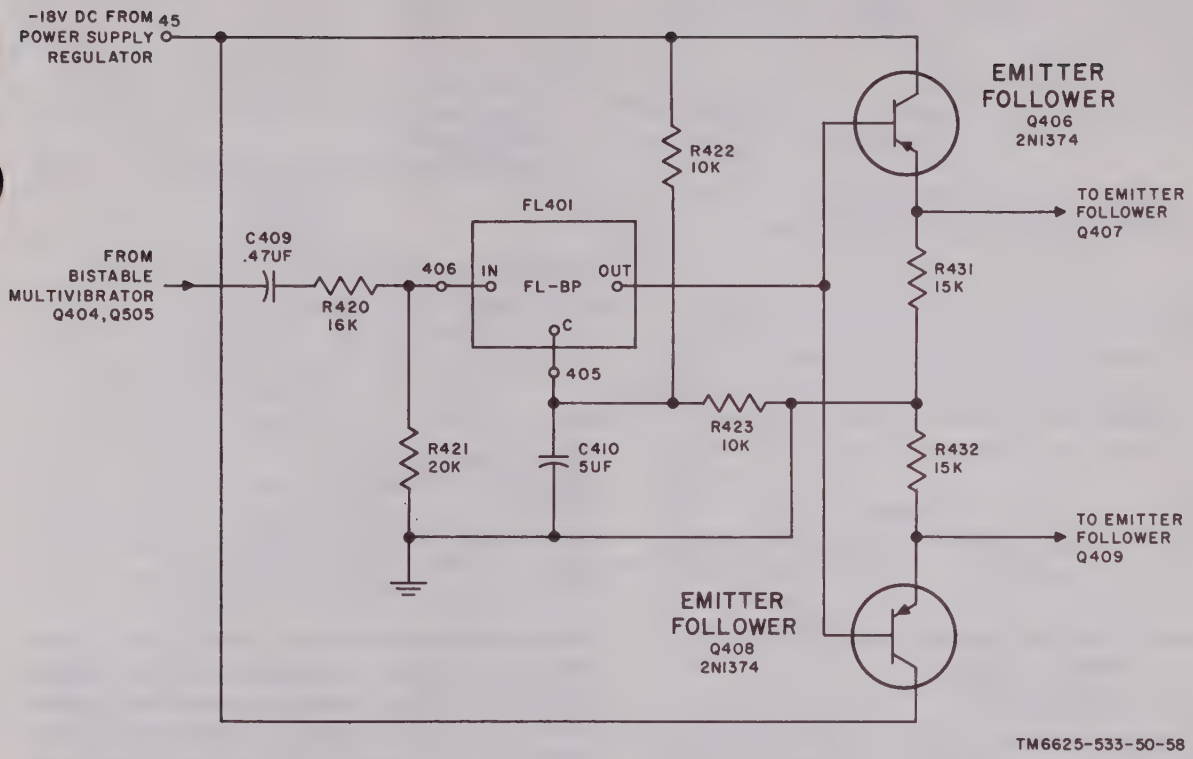


Figure 1–54. Emitter followers Q406 and Q408 plug-in unit 1114-P4, CV–1517/URM–18A, schematic diagram.

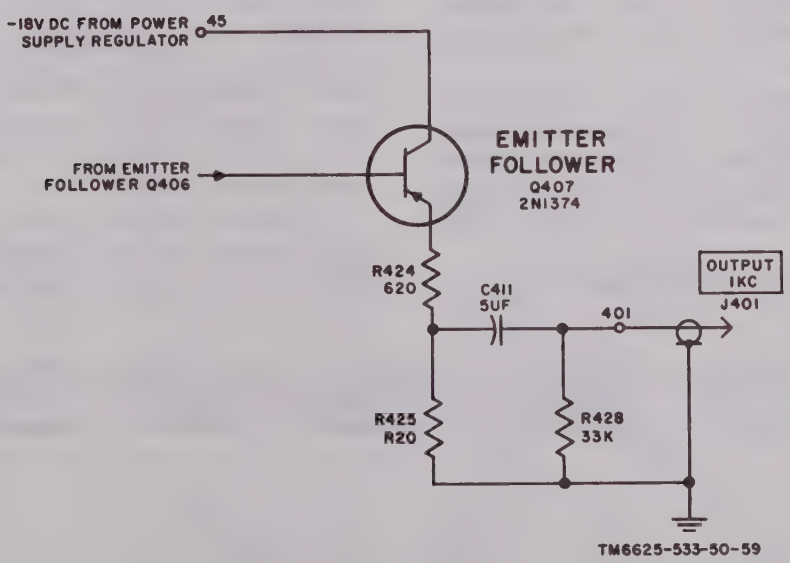


Figure 1–55. Emitter follower Q407, plug-in unit 1114-P5, CV–1517/URM–18A, schematic diagram.

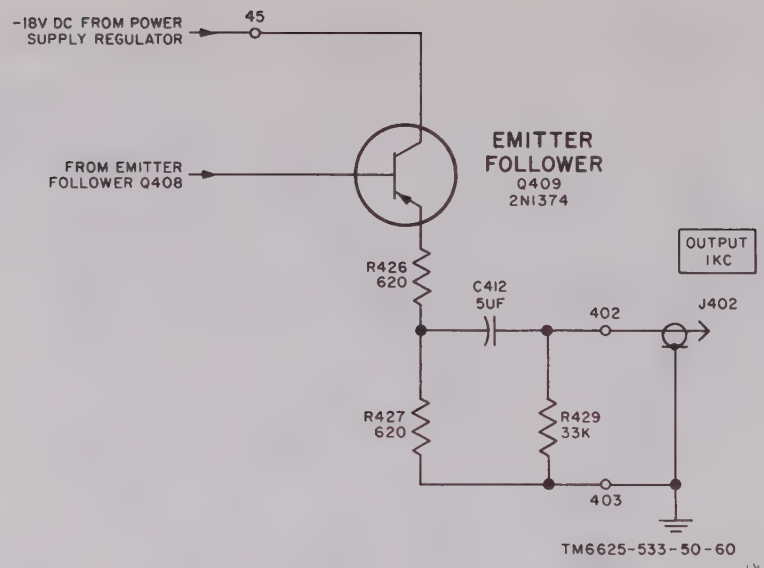


Figure 1–56. Emitter follower Q409, plug-in unit 1114-P4, schematic diagram

1–55. Plug-In Unit 1114-P5, 0.1 Kc, Block Diagram (fig. 1–57)

The general operation of 0.1-kc plug-in unit 1114-P5 is similar to that of 100-kc plug-in unit 1114-P2 (para 1–34). Signal paths and major functional sections of the unit are shown in the block diagram (fig. 1–57) and are discussed in *a* through *e* below. For complete circuit details, refer to the overall schematic diagram (fig. 4–6).

a. Trigger Generator Q501. Trigger generator Q501 receives a 1-kc square-wave signal from 1-kc plug-in unit 1114-P4 and converts the square-wave signal to trigger pulses which are coupled to monostable multivibrator Q502 and Q503.

b. Monostable Multivibrator Q502 and Q503. Monostable multivibrator Q502 and Q503 receives the 1-kc trigger-pulse output of trigger generator Q501 and reacts to every fifth trigger pulse. The output is a 0.2-kc square wave used to activate bistable multivibrator Q506 and Q507. The output signal is also applied to unused buffer Q504.

c. Bistable Multivibrator Q506 and Q507. Bistable multivibrator Q506 and Q507 receives the 0.2-kc square-wave output of monostable multivibrator Q502 and Q503 and divides it by two. The resulting 0.1-kc square-wave outputs of bistable multivibrator Q506 and Q507 are applied to emitter follower Q508 and unused buffer Q505.

d. Emitter Follower Q508. Emitter follower Q508 couples the fundamental component of the 0.1-kc square-wave output from bistable

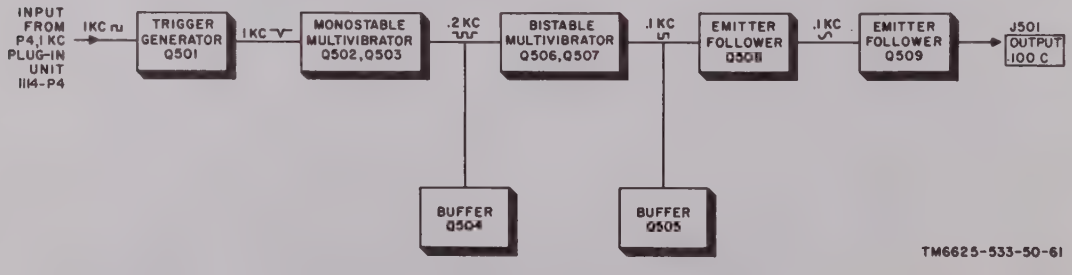


Figure 1–57. Plug-in unit 1114-P5, 0.1kc, CV–1517/URM–18A, block diagram.

multivibrator Q506 and Q507. The resulting Q508 sine-wave output is applied to emitter follower Q509.

e. Emitter Follower Q509. Emitter follower Q509 couples the 0.1-kc sine-wave output of emitter follower Q508 to output 100C J501.

1—56. Trigger Generator Q501, Plug-In Unit 1114-P5 (fig. 1–58)

a. General. The 1-kc square-wave output from 1-kc plug-in unit 1114-P4 is applied to trigger generator Q501 and converted to trigger pulses, which are fed to monostable multivibrator Q502 and Q503.

b. Detailed Operation. The 1-kc square-wave output from 1-kc plug-in unit 1114-P4 is applied to the base of Q501 through coupling capacitor C501. The negative portion of the input square wave will cause Q501 to draw current. The time constant of C501 and R501 is such to produce a sharp-spiked trigger pulse across R501 for each negative portion of the square-wave input signal. Each trigger pulse drives Q501 into conduction. When Q501 conducts, the voltage level at the junction of R502 and R503 becomes less negative. This causes the anode of CR501 to become more positive with respect to its cathode, thereby causing current to flow through the diode from monostable multivibrator Q502 and Q503. Collector supply voltage is supplied through voltage-dropping resistors D502 and R503. Emitter reverse bias is provided by R504 with C502 as a bypass capacitor.

1—57. Monostable Multivibrator Q502 and Q503, Plug-In Unit 1114-P5 (fig. 1–59)

a. General. Monostable multivibrator Q502 and Q503 produces a 2-kc square-wave signal by using every fifth input trigger pulse from trigger generator Q501. The 0.2-kc square-wave signal is used to control the output frequency of bistable multivibrator Q506 and Q507.

b. Detailed Operation. With no input applied, Q503 conducts current and Q502 does not. Emitter voltage is developed by Q503 current flowing through R508. The potential developed by this action is applied as reverse bias to the emitter of Q502. Forward base bias for Q502 is provided by the voltage-divider network consisting R506 and R507 with C504 as bypass capacitor across R507. The forward base-bias potential for Q503 is supplied from

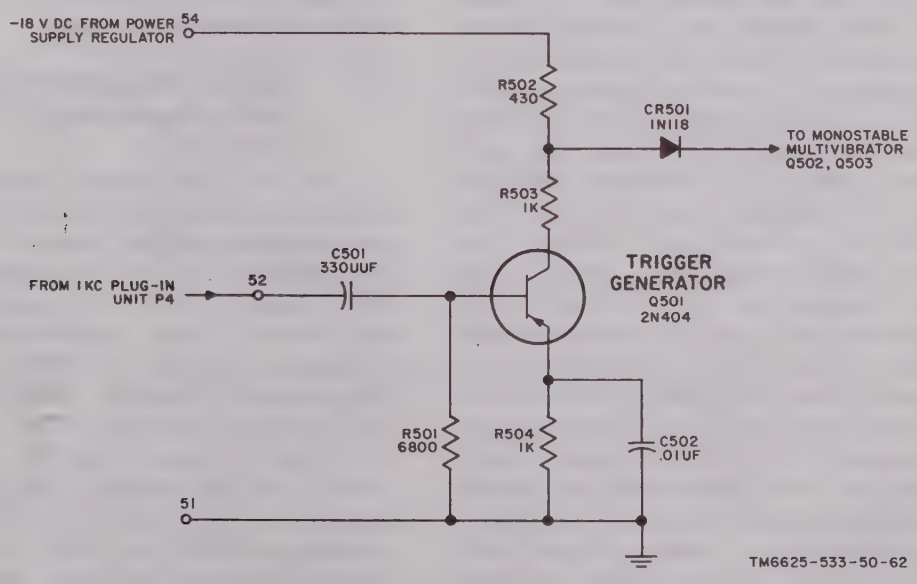


Figure 1–58. Trigger generator Q501, plug-in unit 1114-P5, CV–1517/URM–18A, schematic diagram.

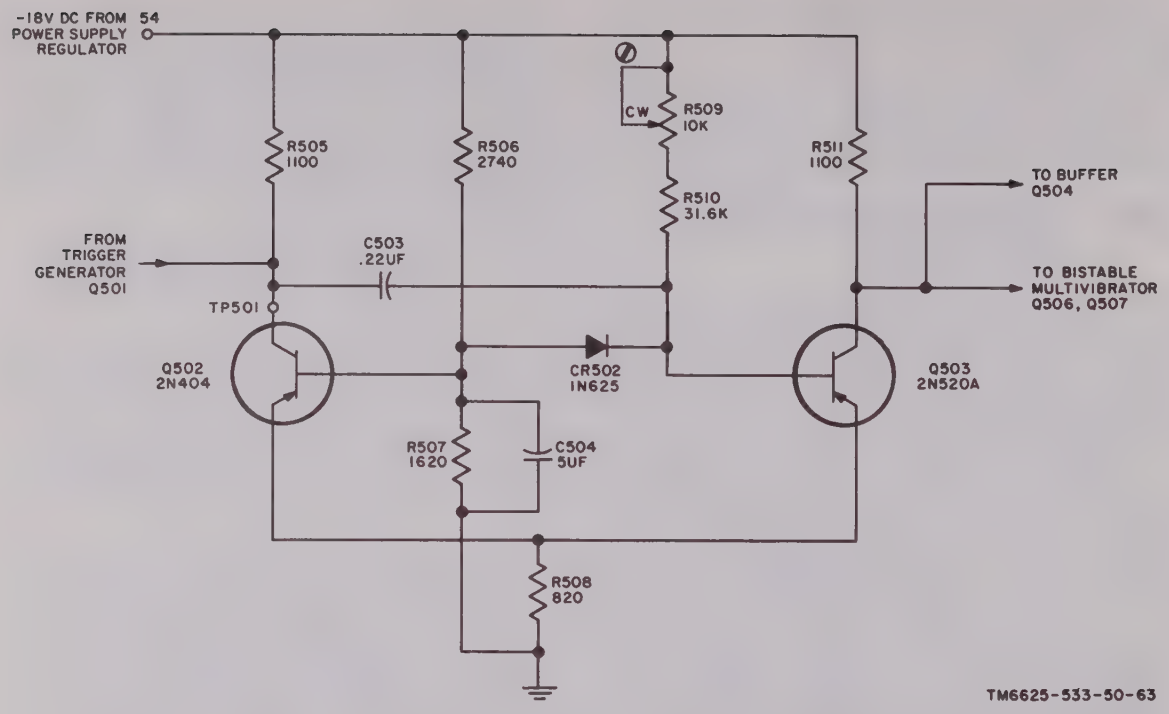


Figure 1–59. Monostable multivibrator Q502 and Q503, plug-in unit CV–1517/URM–18A, schematic diagram.

the voltage-dividing network consisting of R509, R510, CR502 and R507. Resistor R507 is bypass by C504. Variable resistor R509 is adjusted so that five pulses from the trigger generator will override the forward bias of Q503. The pulses are applied by the charging and discharging of coupling capacitor C503. When the five pulses are applied and the base of Q503 becomes more positive than the emitter, current ceases to flow through Q503 and CR502. As conduction ceases through Q503 the potential at the junction of R508 and the emitter of Q502 becomes more positive and effectively increases the forward bias of Q502 to cause conduction. As current flows through the collector of Q502, C503 discharges to a degree which cause the forward bias to return to Q503 transistor Q503 then begins to conduct. The conduction of Q503 causes a greater voltage drop to occur across R508 and applies a more negative potential at the emitter of Q502. This effectively reverse biases Q502, cutting off the transistor. The operation repeats itself each time a series of five trigger pulses from trigger generator Q501 overrides the forward bias on Q503. The collector supply voltage is applied to Q502 through voltage-dropping resistor R505 and to Q503 through voltage-dropping resistor R511.

1–58. Bistable Multivibrator Q506 and Q507, Plug-In Unit 1114-P5 (fig. 1–60)

a. General. The 200-cps negative pulse output from monostable multivibrator Q502 and Q503 is applied to the input of bistable multivibrator Q506 and Q507. Bistable multivibrator Q506 and Q507 coverts the 200-cps signal to two 100-cps signal outputs. One of the outputs is coupled to emitter follower Q508 and the other is coupled to buffer Q505.

b. Detailed Operator. The cathodes of CR503 and CR504 are biased at −6 volts. The −6-volt level is supplied by the power supply regulator through the voltage-divider network consisting of R524 and R525. The anodes of the diodes are also biased at a potential dependent upon which transistor is conducting.

Assume Q507 is conducting and Q506 is not. When this condition exists, current flows through the collector-emitter circuits of Q507. The same collector-emitter current flows through R520 causing an emitter-to-ground potential of approximately −5.8 volts. The same potential exists at the emitter of Q506. During conduction, the Q507 collector voltage is more positive than during a non conducting condition. This causes a small amount of current to flow through R519 and R521, which places the base of Q506 at approximately −6 volts with respect to ground. This condition causes CR503 anode to be at the same potential as its cathode and Q506 to be reverse biased. With Q506 not conducting and no collector-emitter current flowing, the potential at the junction of R517 and R518 is approximately equal to the collector supply voltage, causing maximum current to flow through R523 and R518. The current through R523 causes a potential of approximately −6.8 volts on the base of Q507. This forward biases Q507, increasing conduction and reverse biasing CR504. When monostable multivibrator Q502 and Q503 negative pulses are applied to cathodes of CR504 and CR503, through coupling capacitor C505, CR503 becomes forward biased and conducts. Increased current flows through R519, causing a more negative potential to be placed on the base of Q506 with respect to its emitter. The increased negative voltage at the Q506 base changes the reverse bias to forward bias. This allows Q506 to start conducting. Current begins to flow in the Q506 collector circuit, causing the potential at the junction of R517 and R518 to become less negative. The less negative potential decreases the current flow through R518 and R523. Reduction of current through R523 changes the forward bias on Q507 to reverse bias. As Q507 ceases to conduct, the potential at the junction of R522 and R521 becomes more negative. This produces an increased current

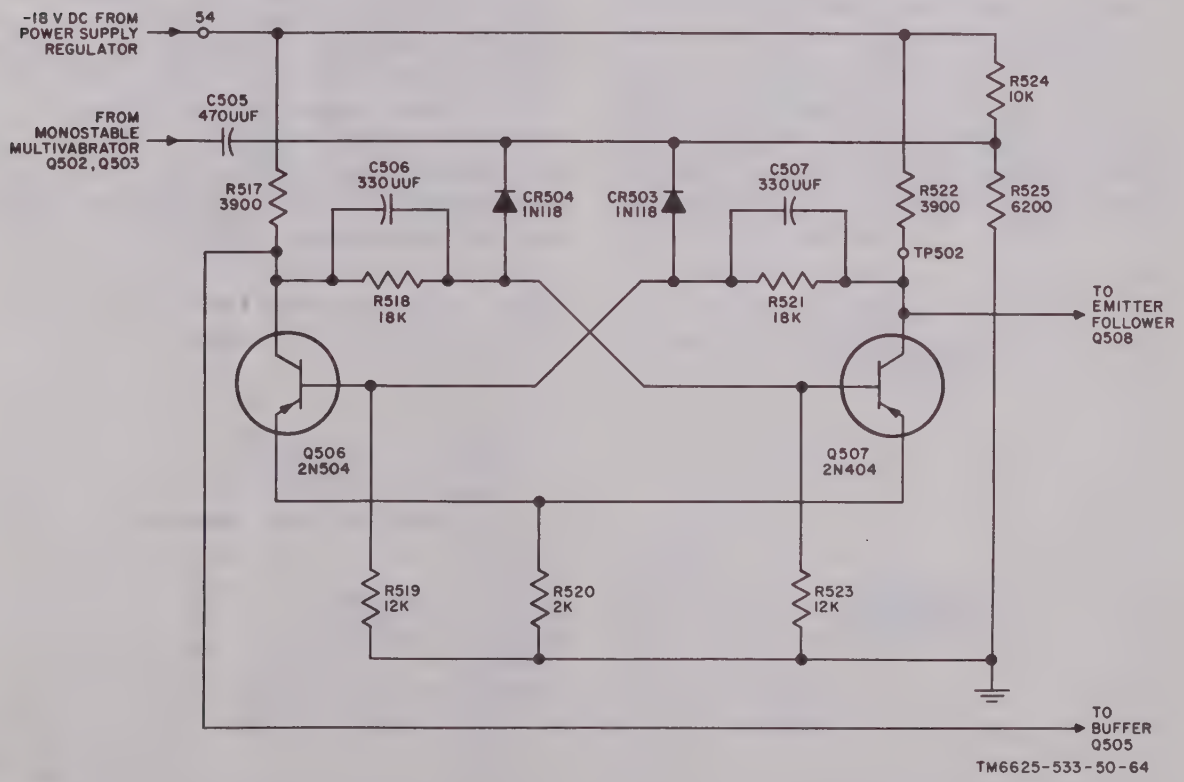


Figure 1–60. Bistable multivibrator Q506 and Q507 plug-in unit 1114–P5, CV–1517/URM–18A, schematic diagram.

flow through R519 and R521. The increased current through R519 increases the forward bias on the base of Q506 and reverse biases CR503. This condition continues until Q507 and CR503 cut off completely and Q506 is driven into saturation. When another negative pulse is received from monostable multivibrator Q502 and Q503 the conduction and cutoff states reverse. This generates a single cycle of output signal from bistable multivibrator Q507 and Q506 for each two cycles of input signal from monostable multivibrator Q502 and Q503. Capacitors C506 and C507 are used to improve frequency response of the two transistors. Output to emitter follower Q508 is taken from the collector of Q507 and the output to buffer Q505 is taken from the collector of Q506.

1–59. Buffer, Q504, Plug-In Unit 1114-P5 (fig. 1–61)

a. General. The 200-cps square wave output of monostable multivibrator Q502 and Q503 is coupled through buffer Q504 to terminal 56 of plug-in unit 1114-P5.

b. Detailed Operation. The 200 cps square-wave output of monostable multivibrator Q502 and Q503 is applied to the base of Q504 through parasitic suppressor resistor R512. The output of Q504 at the emitter is coupled directly to terminal 56 of plug-in unit 1114-P5. Emitter supply voltage is applied through voltage-dropping resistor R513 from the power supply regulator. The Q504 collector is connected to ground through resistor R514.

1–60. Emitter Follower Q508, Plug-In Unit 1114-P5 (fig. 1–62)

a. General. The 100-cps square-wave output of bistable multivibrator Q506 and Q507 is applied to emitter follower Q508 and the 100-cps sine-wave output is fed to emitted follower Q509.

b. Detailed Operation. The 100-cps square-wave output of bistable multivibrator Q506 and Q507 is coupled through coupling capacitor C508 and an impedance-matching network consisting of R526 and R527 to 100-cps bandpass filter FL501. Bandpass filter FL501 selects the fundamental frequency of the square wave to provide an equivalent sine wave of the same frequency. The output of the bandpass filter is coupled directly to the base of Q508. The 100-cps sine-wave output of Q503 is developed across emitter-resistor R533 and the signal is coupled directly to emitter follower Q509. The Q504 collector voltage is applied directly from the power supply regulator. Forward base bias is developed by the voltage-divider network consisting of R528 and R529 with C509 as bypass capacitor across R529.

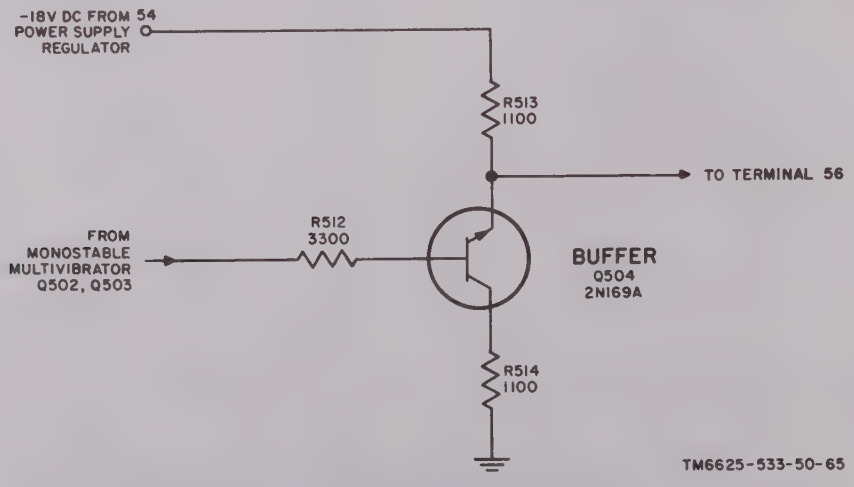


Figure 1–61. Buffer Q504, plug-in unit 1114-P5, CV–1517/URM–18A, schematic diagram.

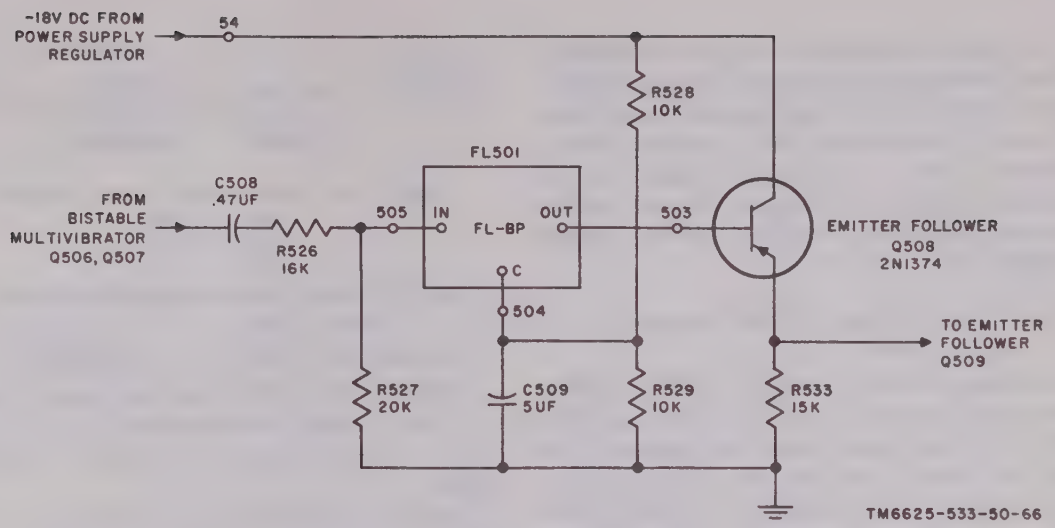


Figure 1–62. Emitter follower Q508, plug-in unit 1114-P5, CV–1517/URM–18A, schematic diagram.

1–61. Buffer, Q505, Plug-In Unit 1114-P5 (fig. 1–63)

a. General. The 100-cps square-wave output of bistable multivibrator Q506 and Q507 is coupled through buffer Q505 to terminal 56 of plug-in unit 1114-P5.

b. Detailed Operation. The 100-cps square-wave output of bistable multivibrator Q506 and Q507 is applied to the base of Q505 through parasitic suppressor resistor R516. The output of Q505 at the emitter is coupled directly to terminal 55 of plug-in unit 1114-P5. Emitter voltage is supplied through voltage dropping resistor R515 from the power supply regulator. The Q505 collector is connected directly to ground.

1–62. Emitter Follower Q509, Plug-In Unit 1114-P5 (fig. 1–64)

a. General. The 100-cps sine-wave output of emitter follower Q508 is applied to Q509. The low-impedance output of Q509 is applied to OUTPUT 100c J501.

b. Detailed Operation. The 100-cps sine-wave output of emitter follower Q508 is directly coupled to the base of Q509. The out-

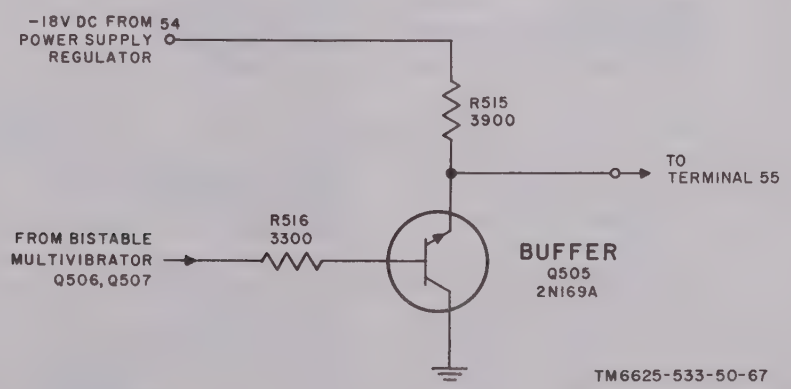


Figure 1–63. Buffer Q505 plug-in unit 1114-P5, CV–1517/URM–18A, schematic diagram.

put of Q509 is generated across the voltage-dividing network consisting of R530 and R531. That portion of the output signal across R531 is coupled to output 100c J501 through coupling capacitor C510. Resistor R532 is an impedance-matching resistor. The collector is connected directly to the power supply regulator.

1–63. Pulse Shaper Block Diagram (fig. 1–65)

The pulse shaper is a device used to convert a 1-mc sine wave to a 1-mc square wave. The signal path and major functional sections are shown in figure 1–65 and are discussed in *a* and *b* below. For complete circuit details, refer to the overall schematic diagram (fig. 4–6).

a. Amplifier Q901. Amplifier Q901 receives a 1-mc sine-wave signal from DRIVING FREQ switch S801 and applies the amplified output to monostable multivibrator Q902 and Q903.

b. Monostable Multivibrator Q902 and Q903. Monostable multivibrator Q902 and Q903 receives the output of amplifier Q901 and applies a 1-mc square-wave signal to DRIVING FREQ switch S801.

Figure 1–65. Pulse shaper, CV1517/URM–18A, block diagram.

1–64. Pulse Shaper Amplifier Q901 (fig. 1–66)

a. General. The 1-mc square-wave signal from DRIVING FREQ switch S801 is applied to pulse shaper amplifier Q901 and the output is fed to monostable multivibrator Q902 and Q903.

b. Detailed Operation. The 1-mc square-wave signal from DRIVING FREQ switch S801 is applied to the base of Q901 through coupling capacitor C901 and parasitic suppressor resistor R902. The amplified signal appears in the collector circuit and is coupled directly to monostable multivibrator Q902 and Q903. Fixed bias is applied to the base through R903. Emitter bias is supplied by R905, with C902 as bypass capacitor. Resistor R901 is a base return resistor and R914 is used to match impedance. Collector supply voltage is supplied through choke L901 and voltage-dropping resistor R904.

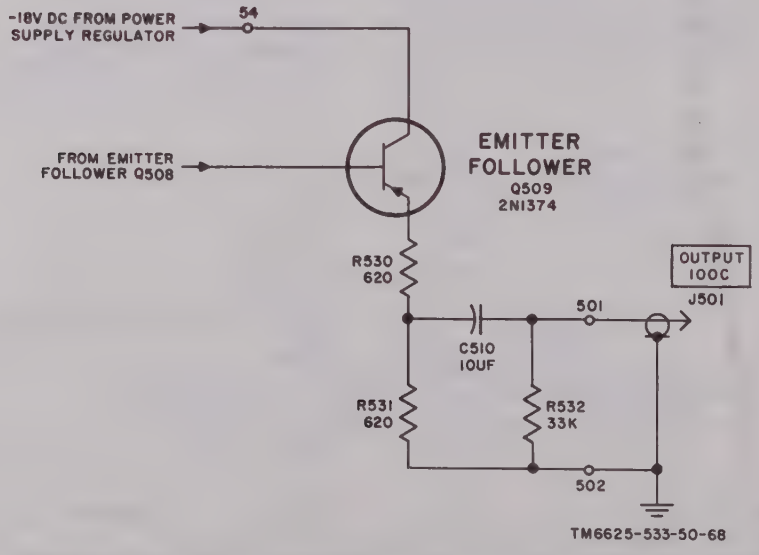


Figure 1–64. Emitter follower Q509, plug-in unit 1114-P5, CV–1517/URM–18A, schematic diagram.

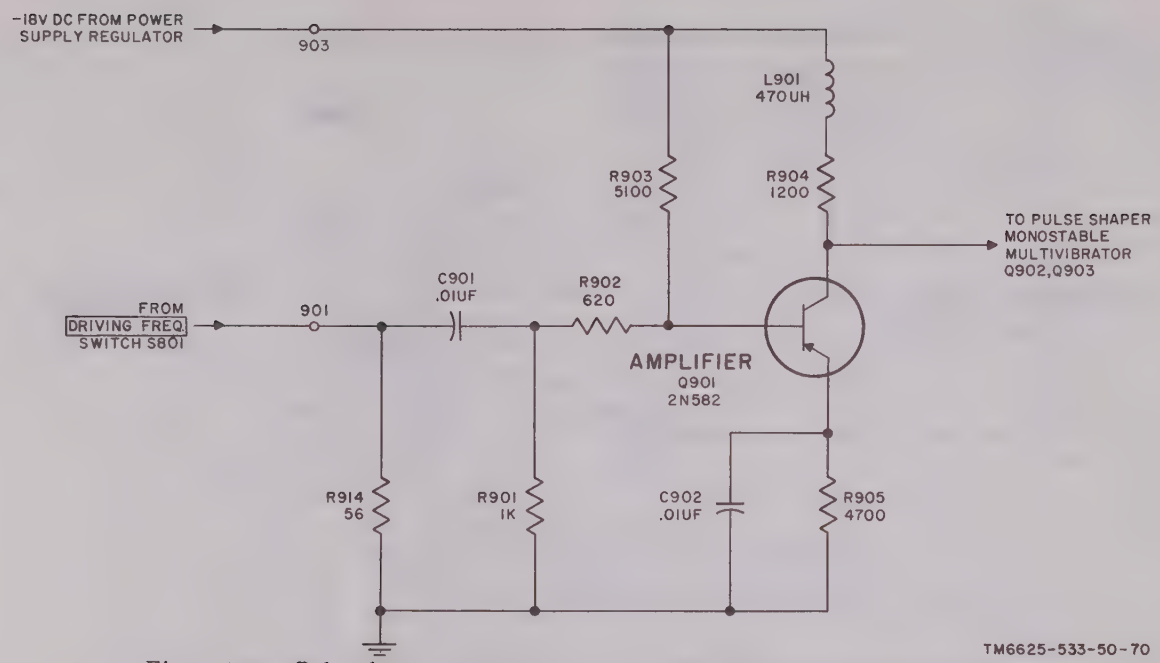


Figure 1–66. Pulse shaper amplifier Q901, CV–1517/URM–18A, schematic diagram.

1–65. Pulse Shaper Monostable Multivibrator Q902 and Q903 (fig. 1–67)

a. General. The 1-mc sine-wave output of pulse shaper amplifier Q901 is applied to monostable multivibrator Q902 and Q903. The output is a 1-mc square wave that is applied to DRIVING FREQ switch S801.

b. Detailed Operation. The 1-mc square-wave output of pulse shaper amplifier Q901 is applied to the base of Q902 through coupling capacitor C903. Assume that Q902 is conducting and Q903 not conducting. Fixed bias is applied to the base of Q902 through the voltage-divider network consisting of resistors R908 and R907, and variable resistor R906. As current flows through Q902, an emitter bias is developed across R911, causing reverse bias to be applied to Q902. The reverse-bias potential is also applied to Q903. Conduction of Q902 makes the voltage level at the junction of R909 and R910 less negative. The decrease of negative voltage results in a small current flow through R913 and R910. The current flow places a potential of the base of Q903 that is less negative than the emitter. The net result is a reverse bias on the base of Q903. The reverse bias prevents Q903 conduction. When the positive half cycle of the input signal is applied to the base of Q902, forward bias is removed and the transistor ceases to conduct. As current flow decreases, the potential at the Q902 collector becomes more negative. The increased negative potential at this point increases current flow through R913 and R910, placing a more negative potential on the base of Q903. As the base of Q903 becomes more negative it begins to conduct. As conduction occurs, collector voltage of Q903 becomes less negative. Under these conditions Q902 is reverse-biased to cut off and Q903 is forward-biased to full conduction. When the positive half cycle of the input signal to Q902 approaches zero and the negative half cycle begins, the forward bias is again applied to the base of Q902. This causes Q902 to conduct, causing the potential at the collector of Q902 to become less negative, which in turn causes the base of Q903 to become less negative. The circuit action cuts the transistor off and increases the collector potential in the negative direction. The cycle is activated again when

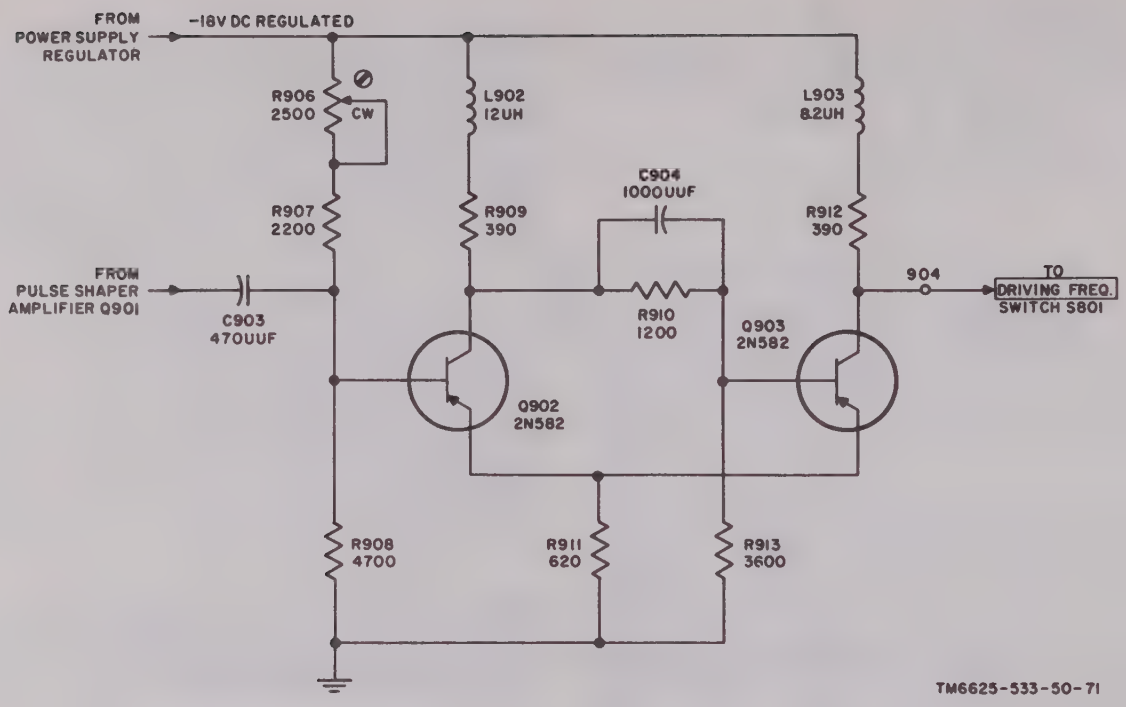


Figure 1–67. Pulse shaper monostable multivibrator Q902 and Q903, CV–1517/URM–18A, schematic diagram.

the next positive half cycle of the input signal is applied to the base of Q902. The circuit action continues so that for each cycle of the input sine wave, an output square wave is generated at the collector of Q903. The collector supply voltage is applied to Q902 through choke L902 and voltage-dropping resistor R909 and Q903 through choke L903 and voltage-dropping resistor R912.

1–66. Power Supply
(fig. 1–68)

a. General. The ac voltage applied to the primary of T801 is stepped down and then rectified by two half-wave rectifiers that are arranged to produce a double output in the filter section. The output of the filter section is applied to the power supply regulator.

b. Detailed Operation. The primary of T801 is shown connected through P801 for 115-volt operation. Note that the two primary windings are connected in parallel. For 230-volt operation the primary windings are connected in series by removing the jumpers between terminals 1 and 3 and 2 and 4 and placing a jumper between terminals 2 and 3. Fuses F801 and F802 are used to protect the equipment against overloads. Stepdown action occurs between primary and secondary windings. For purposes of circuit analysis, assume that the upper side of T801 secondary winding voltage is at a negative potential with respect to the lower side terminal. Under these conditions, for one half of each input ac voltage, current is induced to flow from the upper terminal to charge up filter capacitors C805 and C804 and through CR801 to the lower side terminal of T801 secondary winding. For the other half of each cycle of input ac voltage, the potential across T801 secondary winding reverses and current is induced to flow from the lower terminal through CR802 to charge up filter capacitors C806 and C803 and return to the upper side terminal of T801 secondary winding. Because the full T801 secondary voltage is developed across C805 and C804 on one half the cycle of ac input voltage and the full T801 secondary voltage is also developed across C806 and C803 on alternate half cycles of the input voltage, the sum of the rectified

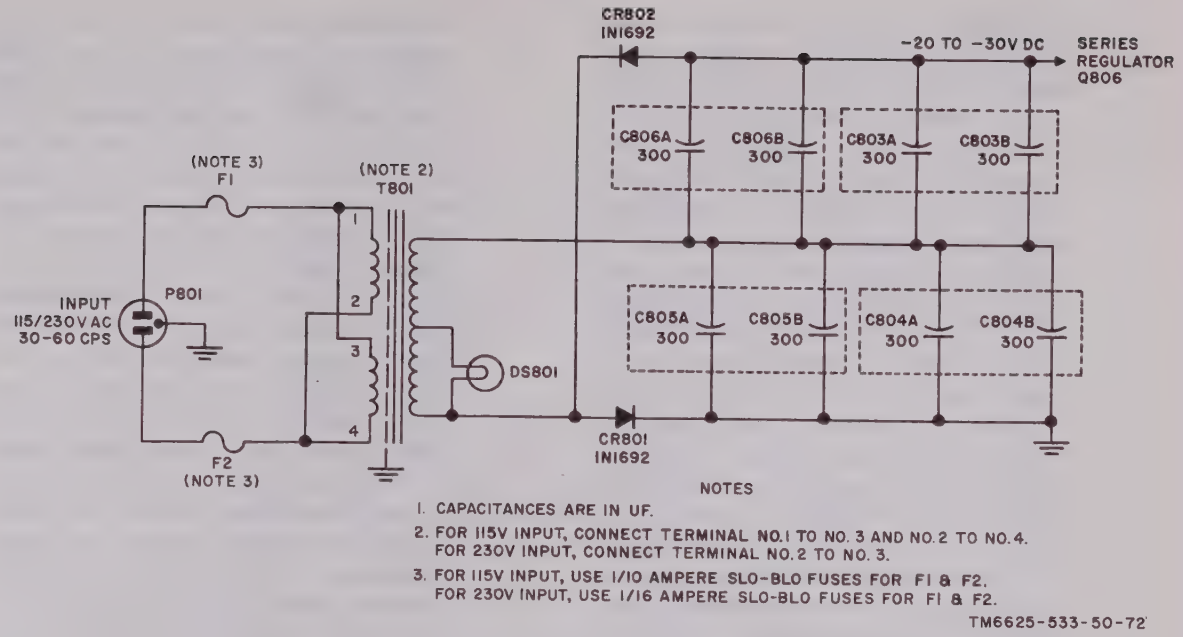


Figure 1–68. Power supply, CV–1517/URM–18, schematic diagram.

voltages across each set of capacitors is double that of the voltage available for rectification across the secondary winding. The doubled voltage output is applied to the power supply regulator. Power form lamp DS801 is tapped from the secondary winding of T801.

1–67. Power Supply Regulator (fig. 1–69)

a. General. The output B— voltage of the power supply is applied to the power supply regulator, which consists of transistors Q801 through Q806. The power supply regulator circuitry maintains a constant output of —18 vdc. It compensates for variations in load conditions or changes in B— output voltage from the power supply. The power supply regulator output voltage is coupled to the pulse shaper and the various plug-in units.

b. Detailed Operation. Constant circuit conditions are covered in (1) below. Circuit conditions, assuming a change in power supply regulator output voltage, are covered in (2) below.

(1) Capacitor C801 provides filtering action for slow ac voltage variations. Capacitor C802 filters rapid voltage surges. A voltage-divider network is formed by fixed value resistors R801 and R803 and variable resistor R802. The portion of the power supply regulator output voltage across R801 and a part of R802 determine the forward base bias on Q801. Resistor R804 is an emitter resistor common to both Q802 and Q801. The voltage drop across R804 determines the amount of emitter reverse bias applied to Q802 and Q801. A voltage-divider network is also formed by R807 and Zener diode CR801. Due to its electrical characteristics, for any variation of the power supply regulator output voltage, the voltage drop across CR801 will remain constant while the full voltage change will be across R807. The voltage drop across R807 determines the forward base bias on Q802. The amount of current conducted by Q801 determines the voltage drop across Q801 collector-load resistor R805. The amount of current conducted by Q802 determines the voltage drop across Q802 collector-load resis-

tor R806. The voltage drop across R805 determines the forward base bias on Q804. The voltage drop across R806 determines the forward base bias on Q803. Transistor Q805 supplies a constant collector reference voltage at the common emitters of Q804 and Q803. Constant current conduction through Q805 is controlled by the constant voltage drop across CR801. Base current to Q805 is supplied by the voltage-dividing network consisting of R808 and R809. The voltage drop across R809 supplies forward base bias voltage to Q805. The voltage drop across R810 supplies reverse bias voltage to Q805. All transistors, Q801 through Q806, normally have a net forward bias. Voltage is supplied to the collector of Q803 through voltage-dropping resistor R811. Voltage to the collector circuit of Q804 is supplied through the parallel combination of R813 and CR802 that is in series with voltage-dropping resistor R812. The voltage drop across R813 determines the forward emitter to base bias on Q806. Diode CR802 supplies a constant collector to base voltage for Q806.

(2) Assume that the load on the power supply regulator increases. The output voltage decreases. The net result desired for regulation is to increase the current conduction of Q806 by circuit action to bring the reduced power supply regulator output voltage back to the normal level. Under the reduced voltage conditions, the forward base bias voltage of Q801 and Q802 will be reduced. Due to Zener diode CR801 action, the forward base bias on Q802 will be reduced more than that of Q801. The emitter reverse bias for both Q802 and Q801 will remain equal because the voltage drop across R804 is common to emitter circuits of Q802 and Q801. The net result is that the collector of Q802 becomes more positive with respect to ground while the collector of Q801 becomes more negative. Since the collector voltages of Q802 and Q801 affect the forward base biases of Q803 and Q804, respectively, the current conduction of Q804 increases while the current conduction of Q803 decreases. This change of current through Q804 and Q803 holds the current through Q805 constant. The increased current through Q804 increases the current flow through R813. The increased current flow through R813 increases the forward emitter to base bias voltage on Q806. The increased forward bias on Q806 causes Q806 to conduct more current. The additional current to the power supply regulator load increases the power supply regulator output voltage. When the output voltage reaches normal level, the changing action stops. If the output load decreases, the output voltage increases with the result that the circuitry action is opposite of that described above.

Section V. FUNCTIONING OF FREQUENCY METERS FR–43A/URM–18, FR–44/URM–18, AND FR–45A/URM–18

1–68. Frequency Meters FR–43A, –44, and –45A/URM–18 Block Diagram (fig. 1–70)

a. Frequency Meters FR–43A/URM–18, FR–44/URM–18, and FR–45A/URM–18 are designed for use in making frequency measurements. All three units are identical in use, differing only in the frequency ranges covered. The block diagram (fig. 1–70) applies to all three units. For complete circuit details, refer to the overall schematic diagrams (figs. 1–84, 1–85, and 1–86). Each unit has its own heterodyne-frequency meter, regenerative

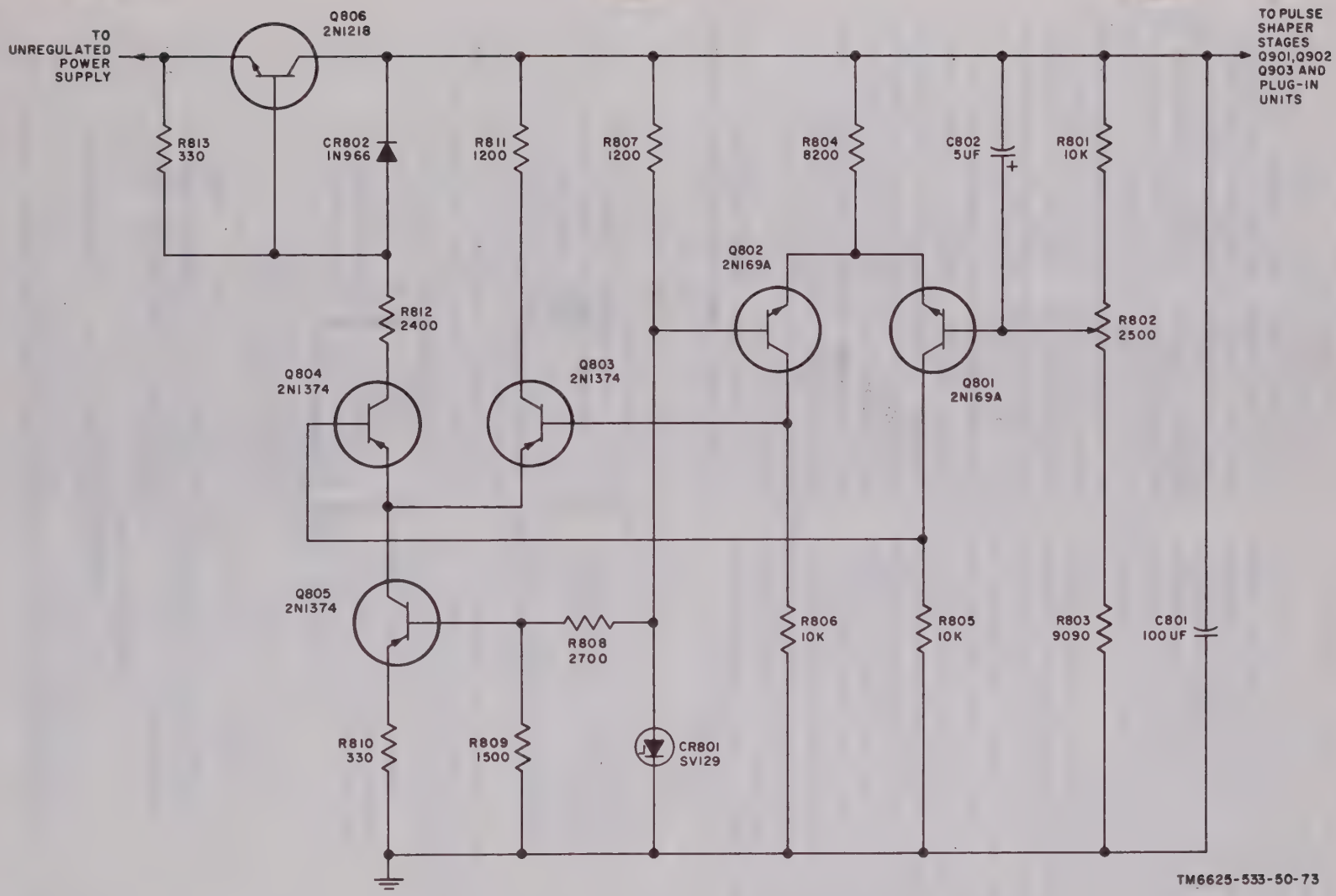


Figure 1–69. Power supply regulator, CV–1517/URM–18A, schematic diagram.

detector, and power supply. The detector circuit of Frequency Meter FR–45A/URM–18 differs slightly from those in the other two frequency meter units.

b. In the frequency meter section, frequency meter RANGE switch S1 selects the desired range of oscillator V1, which is coupled to buffer amplifier V2. This buffer amplifier, in turn, is coupled to rectifier V3 for producing harmonics. The output of V3 is connected to Control Panel SB–105A/URM–18 for transfer to other measuring units.

c. In the detector section, detector RANGE switch S4 selects the desired range of detector V6. The frequency ranges of the frequency meter section and the detector section are the same at corresponding positions of the range switches. The output of the detector is fed into three-stage, audiofrequency amplifier V7, V8A, and V8B and its audiofrequency output is connected to Control Panel SB–105A/URM–18 for transfer to other measuring units.

d. The power supply section of each unit consists of a transformer, a rectifier, an ac filter, and a voltage regulator, which furnishes power for the filaments, plates, and indicating lights.

1–69. Frequency Meter RANGE Switch S1 and Oscillator V1 (fig. 1–71)

Note. Because of similar circuits, with the exception of the FR–45A/URM–18 detector V6 stage, the FR–43A/URM–18 circuitry will be used to represent that of the FR–44/URM–18 and the FR–45A/URM–18.

a. The modified Colpitts oscillator circuit is designed to reduce the effects of changes in tube capacitances of V1. With capacitors C4 and C5 in series and across the tuned circuit of L1 or L2, and C6 and C7, effective changes of frequency of the oscillator due to changes in tube capacitance are reduced. Two inductors only, L1 and L2, are used for the nine ranges. The ratio of the maximum to the minimum frequency used in each range is 1.41 to 1.0. The two coils (L1 and L2) give a fundamental frequency range ratio of 2 to 1. By harmonic generation, through the use of the amplifier and rectifier (figs. 1–72 and 1–73), each coil is used for several ranges. Each harmonic range has a calibrated tuning scale driven by turning capacitor C7. Capacitor C18 is used for fine tuning.

b. In this type of oscillator, the amplitude of oscillation varies considerably as inductors

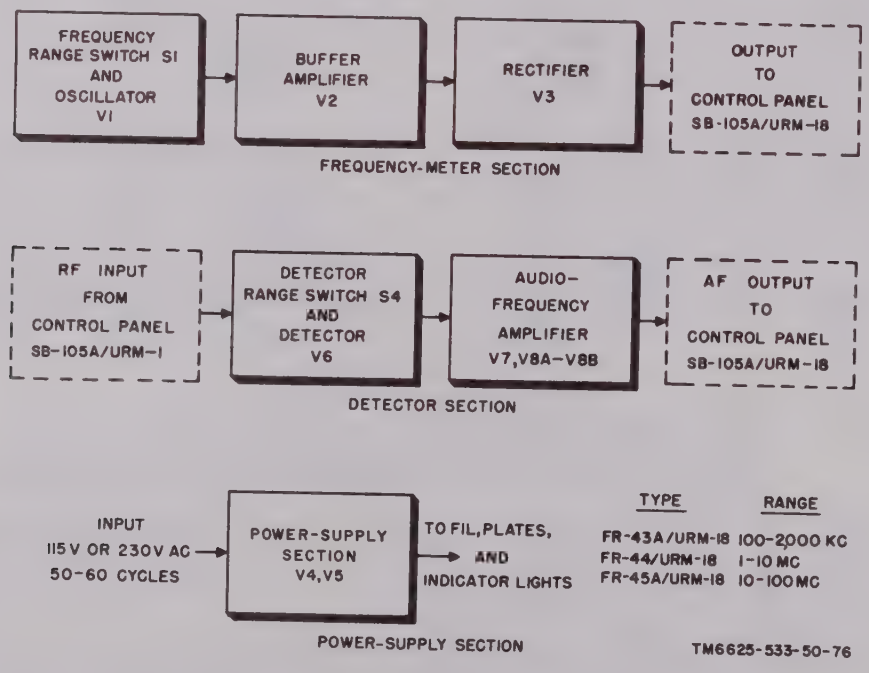


Figure 1–70. Frequency Meters FR–43A, FR–44/URM–18, FR–45A/URM–18 block diagram.

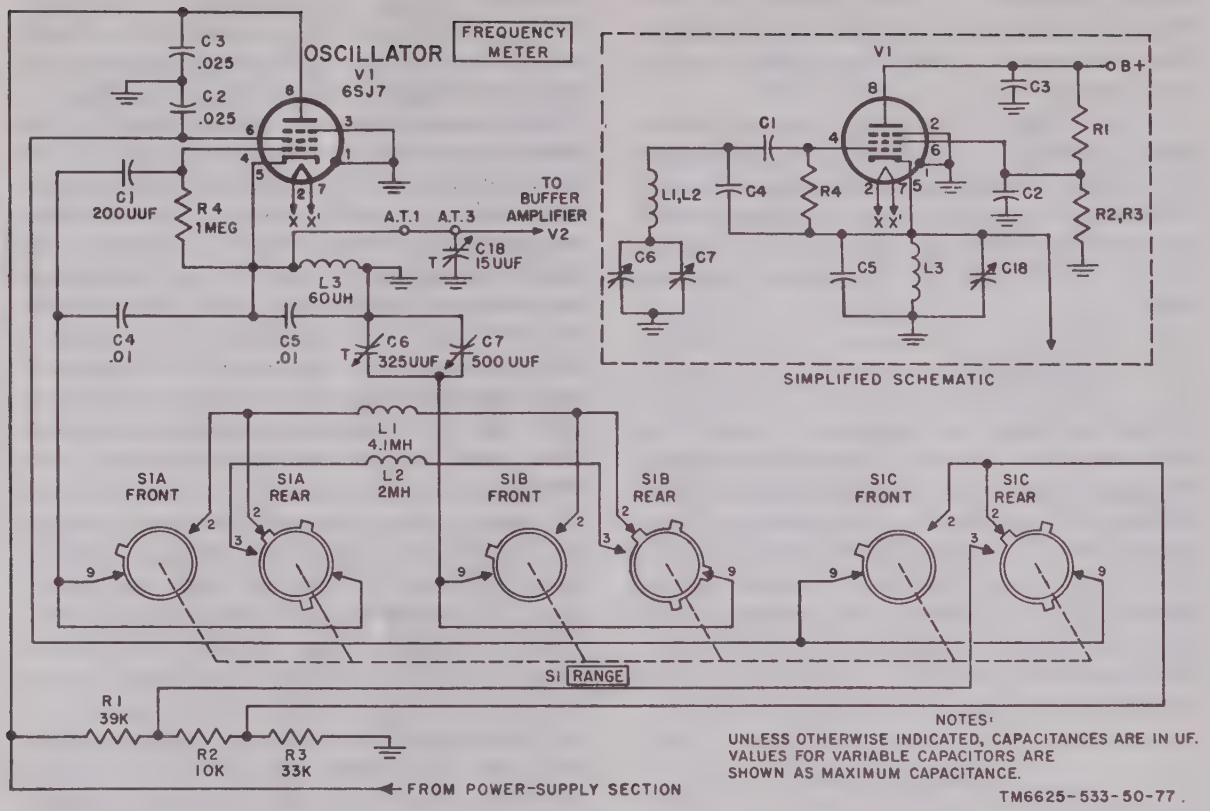


Figure 1–71. Frequency meter range switch S1 and oscillator V1, FR–43A/URM–18, schematic diagram.

are changed. To hold the amplitudes of the various ranges more constant, voltage dividers R1, R2, and R3 and switch S1 provide for changing oscillator V1 screen voltage automatically with a change in frequency range. Capacitors C2 and C3 bypass rf from the B+ line. The oscillator tank signal is coupled to the control grid through coupling capacitor C1 across grid-leak resistor R4. The oscillator V1 output signal is taken from the V1 cathode.

1–70. Buffer Amplifier V2 (fig. 1–72)

a. The oscillator output signal V1 is fed to the control grid of buffer amplifier V2 through coupling capacitor C8. Buffer amplifier V2

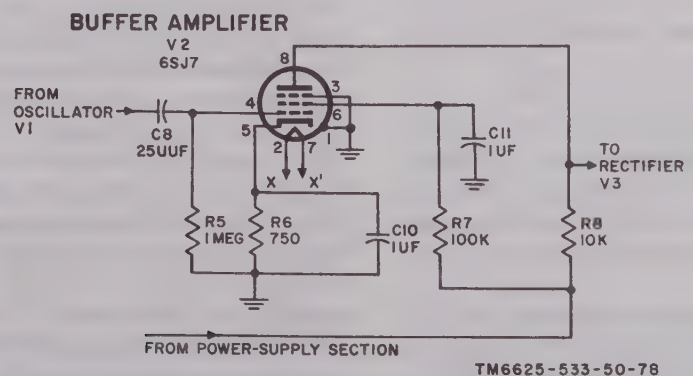


Figure 1–72. Buffer amplifier V2, FR–43A/URM–18, schematic diagram.

isolates oscillator V1 from rectifier V3. The output signal of buffer amplifier V2 is taken from the plate of V2 and is fed to the following stage, rectifier V3.

b. The dc return to ground from the control grid is through R5. Cathode bias is developed across R6. Resistor R6 is bypassed by C10. Plate and screen grid voltage is applied through voltage-dropping resistors R8 and R7. Capacitor C11 decouples the screen-grid voltage supply.

1–71. Rectifier V3
(fig. 1–73)

Rectifier V3 is a germanium diode. The input signal to V3 is supplied from buffer amplifier V2 through coupling capacitor C12 and across rf choke L4. The rectifier voltage output from V3 is developed across potentiometer R9. The rectifier V3 output signal across R9, rich in harmonics, passes through the variable tap of R9 and to the output terminal freq meter output J1 through isolating resistor R10 and coupling capacitor C13.

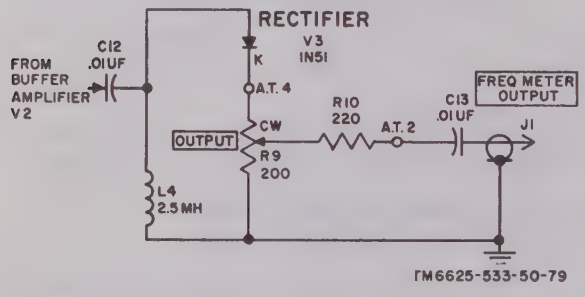


Figure 1–73. Rectifier V3, FR–43A/URM–18, schematic diagram.

1–72. Detector Range Switch S4 and Detector V6
(fig. 1–74)

Detector stage V6 is a regenerative detector that combines the principles of the tickler feedback oscillator and the grid-leak detector. Detector RANGE switch S4 is used to switch the appropriate range coils into the operating circuit.

a. Regeneration consists of feeding back a portion of the output voltage of a stage into the input circuit. This is accomplished by inductive coupling between the coil in the plate circuit and the coil in the control grid circuit of V6. The voltage fed back is in phase with the input voltage and reinforces it. The effect of regeneration is to lower the effective resistance of the control grid tuned circuit and raise its effective Q. This increases the voltage rise at resonance, equivalent to added amplification, and increases the selectivity of the stage. The amount of regeneration is controlled by varying the screen-grid voltage applied to V6. Varying the screen-grid voltage varies the gain of the tube which in turn varies the amount of energy transfer between the plate and control grid coils. The regeneration may be increased to a point where the stage becomes self-oscillating.

b. Regenerative detector V6 can be operated in an oscillating or nonoscillating condition. In an oscillating condition, the amount of regeneration has been adjusted to such a point that the stages become self-oscillating. The frequency of self-oscillation is set by tuning the control grid circuit. The grid circuit tuning can be varied by the choice of the control grid tank coil, and the adjustment of the control grid tank capacitor. When an unknown signal is fed into the V6 control grid circuit from J2, the unknown signal heterodynes with the signal developed by self-oscillation. The heterodyne, or beat note is detected by the resistance-capacitance (rc) grid-leak combination in the control grid circuit. The rf portion of the detected signal is filtered out in the plate circuit of V6 and the resulting audio signal is coupled to audio stages V7 and V8. When zero beat is achieved, the unknown frequency is indicated by the setting of the DETECTOR dial.

c. When V6 operates as a nonoscillating detector, two signals, a known and an unknown, are fed into the V6 control grid circuit from J2. The control grid circuit must be tuned to one of the input signals so that regeneration takes place. The regeneration is adjusted to a point below where self-oscillation may take place. The two input signals heterodyne and the beat note is detected. The frequency of the known signal is varied until zero beat is established. The known frequency at this point is equal to the unknown frequency.

d. The tuned control grid circuit consists of

one of coils L8A through L16A in parallel with a series-parallel combination of capacitors consisting of capacitor C29 in series with the parallel capacitance combination made up of tuning capacitor C30 and trimmer capacitor C31. Input signals from J2 are applied to line terminating resistor R40 and are coupled to V6 control grid circuit through coupling capacitor C33. Capacitor C32 and resistor R25 provide the combination for grid-leak detection. One of the plate tickler coils L8B through L16B, simultaneously switched with one of the control grid coils L8A through L16B, inductively couples the feedback voltage from the plate to the control grid circuit. The detected audio output is taken from the output of the rf pi-type filter consisting of C28, R24, and C27. Plate voltage is applied to V6 through a decoupling network consisting of R30 and C36 and through voltage-dropping resistors R29 and R24 and one of the inductors L8B through L16B. Screen grid voltage from the B+ line is applied through voltage-dropping resistor R28, adjusted by detector REGENERATION control R27 and fed to the screen through the decoupling network consisting of C34, C35, and R26. Detector REGENERATION control R27 controls regeneration by varying the screen-grid voltage. This is turn varies the amplification of V6 and the amount of plate to control grid feedback voltage.

e. Stage V6 of the FR–45A/URM–18 (fig. 4–9) differs from that of the FR–43A/URM–18 and FR–44/URM–18 in that it is an oscillating detector. Although the detector stages differ in circuitry, operationally they are similar. The FR–45A/UMR–18 V6 stage uses a Colpitts oscillator rather than a tickler feedback type oscillator. The oscillator signal, also beats with the input signal, and the resultant beat is detected by grid-leak detection. A coil, one of L8 through L17, selected by use of S4, in parallel with C30 forms the common plate grid tank for the oscillator. Capacitors C29 and C31 couple the oscillator and input signals to grid-leak resistor R25. The remainder of the V6 circuitry is similar to that of the FR–43A/URM–18 and FR–44/URM–18, except that the detector REGENERATION control varies the plate voltage rather than the screen voltage.

1–73. Audiofrequency Amplifier V7, V8A, and V8B
(fig. 1–75)

a. Audiofrequency amplifiers V7 and V8A are resistance-capacitance coupled stages that amplify the detector V6 output audio signal.

b. The input signal is fed through coupling capacitor C37 to the control grid of V7. Control grid return to ground is through R31. Cathode-bias voltage is obtained from cathode resistor R32, bypassed by C38. Plate voltage is applied to V7 through voltage-dropping resistor R33. The V7 plate output signal is coupled to the V8A control grid through coupling capacitor C39.

c. The second stage and output stages are combined in one tube, V8A and V8B. The second stage (V8A) is identical with the first (V7). The last audio stage, output stage (V8B) is a cathode follower with the output taken across the combined cathode resistance of R38 and R39. The control grid return to cathode is through resistors R41, R37, and R38.

d. The cathode output signal is coupled through C42 to DETECTOR OUTPUT J3 jack.

1–74. Power Supply Section (FR–43A/URM–18)
(fig. 1–76)

a. The power supply section includes power transformer T1; rectifier V4; filter consisting of C22, C23, C24, R16, R17 and R18; series resistor R19; and regulator tube V5. The power supply steps up the line voltage and rectifies and filters it to produce dc plate and screen voltages. The power supply also steps down a portion of the line voltage for the filaments of the tubes.

b. The line power is supplied to T1 transformer primary windings through power jack J4; rf filter consisting of C20 and C21; fuses F1 and F2; and POWER-OFF switch S3. The primary windings of T1 are connected in parallel for 115-volt operation. For 230-volt operation, the T1 primary windings are connected in series.

c. The pulsating dc voltage from full-wave rectifier V4 is filtered by the rc filter consisting of R16, R17, R18, C22, C23, and C24, and is used to supply unregulated plate and screen-

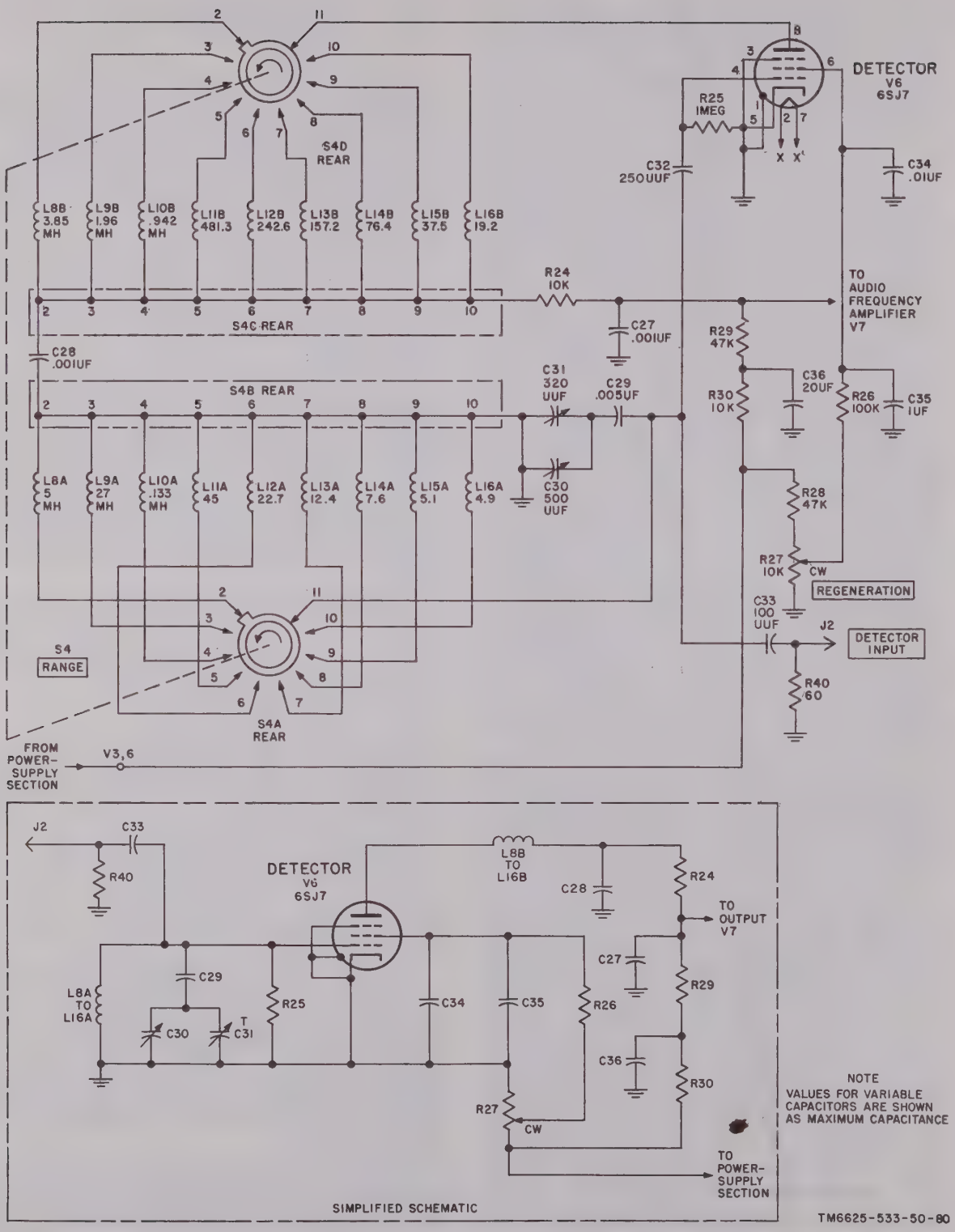


Figure 1–74. Detector RANGE switch S4 and detector V6, FR–43A/URM–18, schematic diagram.

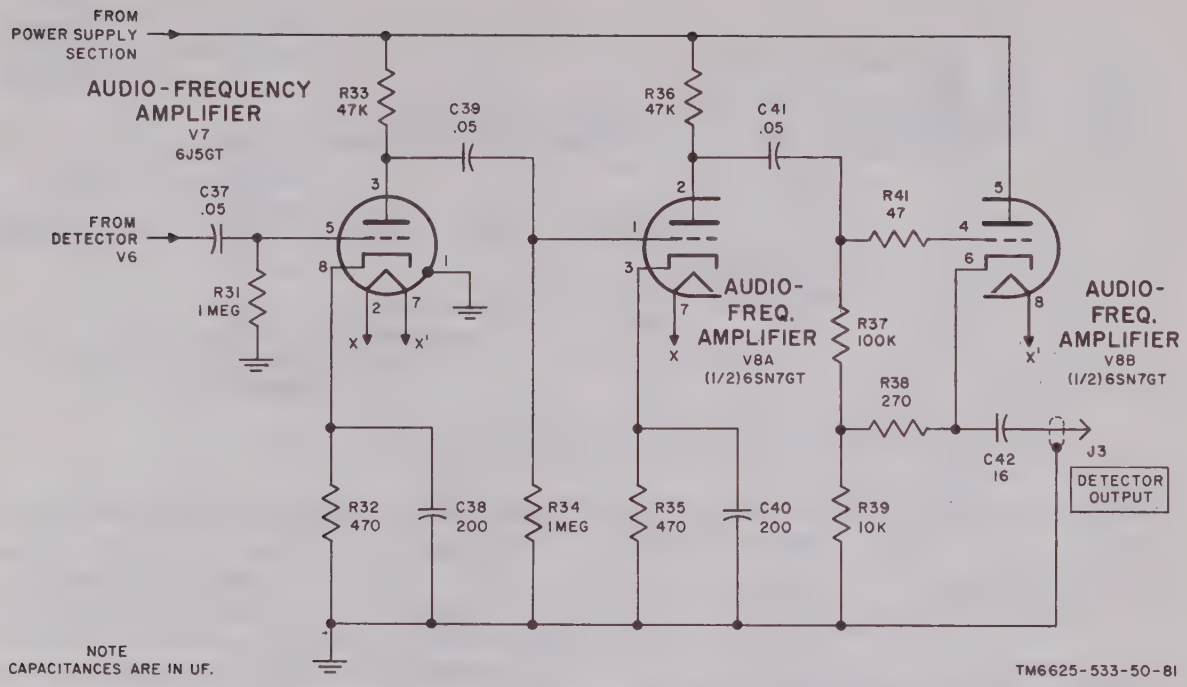


Figure 1–75. Audiofrequency amplifier V7, V8A, and V8B, FR–43A/URM–18, schematic diagram.

grid voltages to buffer amplifier V2, audiofrequency amplifiers V7, V8A, and V8B and to voltage regulator V5 through regulator series resistor R19.

d. Regulated plate voltage is obtained from the plate of voltage regulator tube V5 and is used to supply plate and screen-grid voltages to detector V6 and only to oscillator V1 when PLATE-OFF switch S2 is in the PLATE position.

e. Indicator light DS2 for the detector RANGE dial lights when POWER-OFF switch S3 is in the POWER position. Indicator light DS1 for the frequency meter RANGE dial lights when PLATE-OFF switch S2 is in the PLATE position. Power for the indicator lights is taken from the rectifier filament transformer winding. The second filament winding is used to supply filament voltage to other tubes in the unit.

Section VI. FUNCTIONING OF GENERATOR, SIGNAL SG–42/URM–18

1–75. Generator, Signal SG–42/URM–18 Block Diagram (fig. 1–77)

a. Generator, Signal SG–42/URM–18 is designed for measuring the audiofrequency difference between the unknown frequency and a standard harmonic of 10 kc. This difference ranges from 0 to 5 kc for all such measurements. The signal generator consists of a 42- or 47-kc fixed-frequency oscillator and a 42-kc to 47-kc variable-frequency oscillator, each having an associated buffer amplifier; a detector; an rf filter; a mixer; and mixer input and audio output amplifiers. The unit also contains a power supply section. The schematic diagram of the unit is shown in figure 4–10.

b. The 42- or 47-kc fixed-frequency oscillator V1 output signal is fed to buffer amplifier V2, and 42-kc to 47-kc variable-frequency oscillator V4 output signal is fed to buffer amplifier V3. The output signals of V2 and V3 are coupled together and are fed to detector V5A. From the detector, the beat frequency is filtered

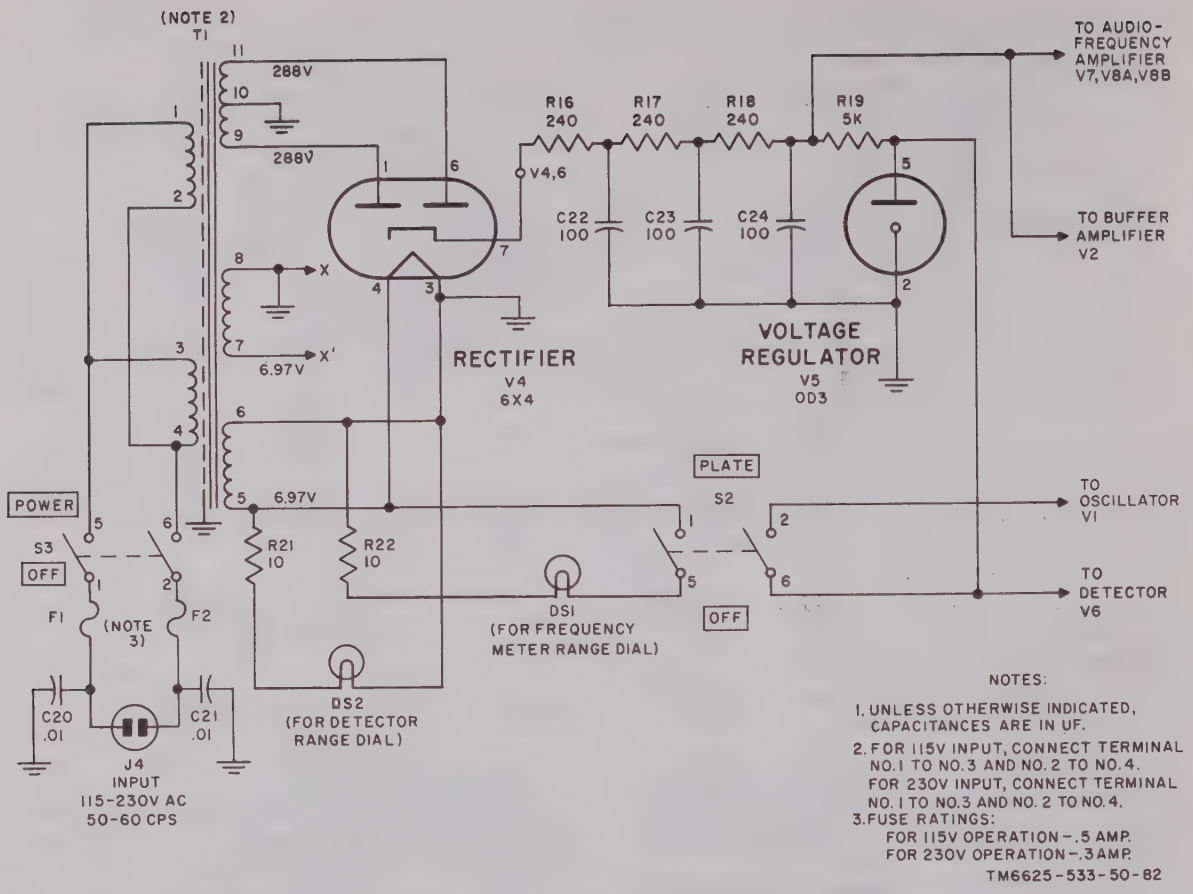


Figure 1–76. Power supply section, FR–43A/URM–18, schematic diagram.

through the rf filter circuit and is coupled to mixer V6A. The unknown audiofrequency, 0 to 5,000 cycles, is applied to the mixer through input amplifier V7. The output of the mixer is then fed to audio amplifier V5B and V6B and zero beat is indicated on OUTPUT meter M1 or heard in the headphones or loudspeaker. The Δ f DIRECT scale N1 and Δ f REVERSE scale N2 (fig. 4–10) make frequency measurements possible by addition only. This feature of Generator, Signal SG–42/URM–18 is described in *c. d.* and *e.* below.

c. The audiofrequency output from 0 to 5,000 cycles is derived from the difference in frequency of two rf oscillators; one operating at a fixed frequency of 42 kc or 47 kc, and the other operating at a variable frequency of 42 kc to 47 kc. The fixed frequency of 42 kc or 47 kc is selected by the position of REVERSE-DIRECT switch S2. As the FREQUENCY dial is moved over the 0 to 5,000 divisions of the direct scale (with S2 in the DIRECT position), the output frequency varies from 0 upward to 5,000 cycles. As the dial is moved over the 5,000 to 10,000 divisions of the reverse scale (with S2 in the REVERSE position), the output frequency varies from 5,000 cycles downward to 0. The REVERSE scale is separate from the DIRECT scale and is marked 5,000 to 10,000 cycles. The scales are illuminated by two separate lights (DS1 and DS2) and the illumination changes from one scale to the other as REVERSE-DIRECT switch S2 is operated.

d. The direct reading scale is used when the frequency of the unknown signal is known to be greater than that of the 10-kc standard frequency harmonic with which it is being beat.

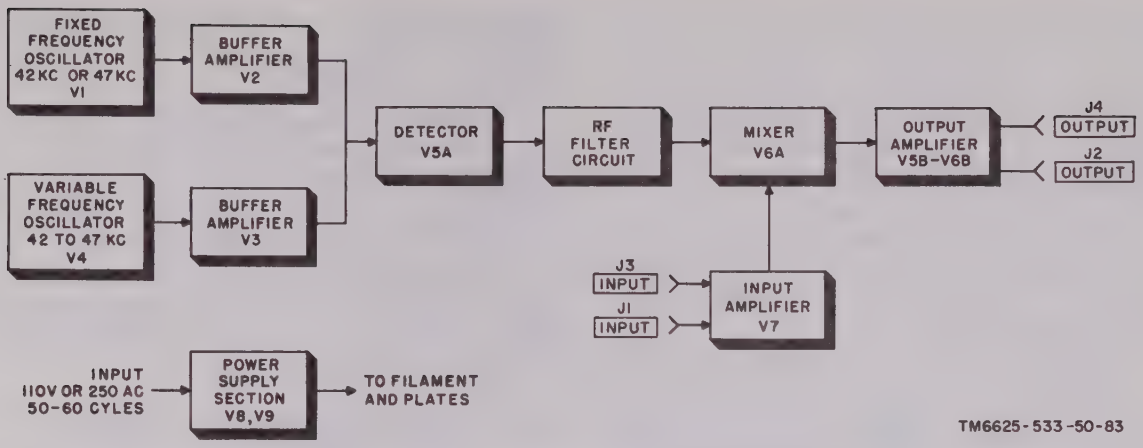


Figure 1–77. Generator, Signal SG–42/URM–18, block diagram.

The beat frequency indicated on the direct scale is added to the standard frequency to give the unknown frequency.

e. The reverse scale is used when the frequency of the unknown signal is known to be less than that of the 10-kc standard frequency harmonic. The zero beat reading on the reverse scale must be added to the next lowest 10-kc standard frequency harmonic to give the unknown frequency.

1–76. Fixed-Frequency Oscillator V1 (42 Kc or 47 Kc) (fig. 1–78)

a. The oscillator tuned circuit consists of L1, C2, C3, and C4. Adjustments for the Δ f

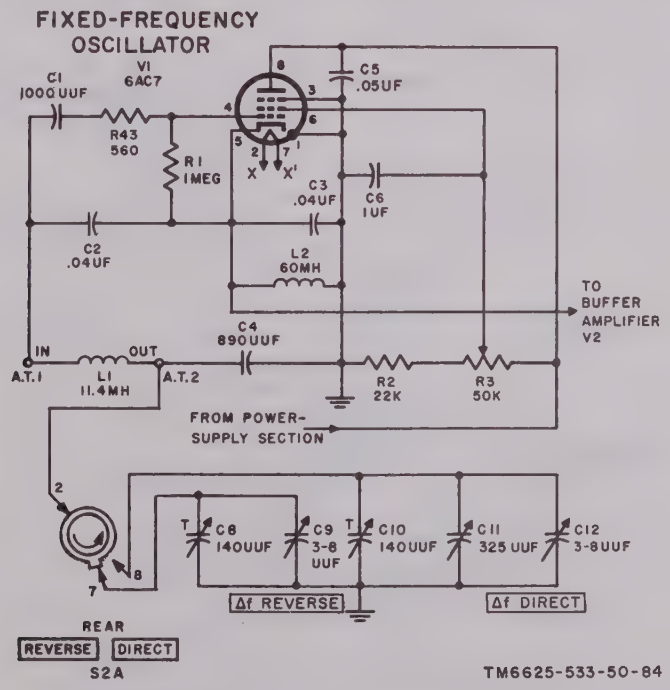


Figure 1–78. Fixed-frequency oscillator V1, 42 kc or 47 kc, schematic diagram.

DIRECT scale is provided by C10, C11, and C12, and S2 in DIRECT position. Adjustments to Δ f REVERSE scale is provided by C8 and C9, and S2 in REVERSE position. Capacitor C9 is the zero-set capacitor for the REVERSE position and C12 is the zero-set capacitor for the DIRECT position.

b. The input to oscillator tube V1 is taken across the tuned circuit by way of grid coupling capacitor C1 and suppressor resistor R43. Grid bias is provided by R1.

c. The plate of oscillator tube V1 is bypassed to ground for radiofrequencies by C5. Rf choke L2 provides a path for the dc cathode current of the tube. The screen-voltage supply for V1 is obtained from voltage dividers R2 and R3, bypassed by C6. Variable resistor R3 regulates the amplitude of oscillation.

d. Output from the oscillator is taken from the cathode across C3 and L2.

1–77. Buffer Amplifier V2 (fig. 1–79)

a. The buffer amplifier is a cathode follower and the input signal is grid-coupled through C13 from fixed-frequency oscillator V1. Output it taken from cathode resistor R5 or R8 determined by position of REVERSE-DIRECT switch S2. Bias is provided by R7 through grid-leak resistor R4.

b. Separate output adjustments are provided for the two positions of REVERSE-DIRECT switch S2, to account for the differences in oscillator level. The output signal is coupled to detector V5A through isolating resistor R6.

c. Indicator lights DS1 and DS2 are switched so that the proper index on the FREQUENCY dial is illuminated for the DIRECT and REVERSE switch positions.

1–78. Variable-Frequency Oscillator V4 (fig. 1–80)

a. The oscillator tuned circuit consists of L3, C17, C18, C19, C21, C20, and C22. The main FREQUENCY control is C19 and the trimmer adjustments are C20, C21, and C22.

b. The input to oscillator tube V4 is taken from the tuned circuit through grid capacitor C16 and suppressor resistor R44 and across grid bias resistor R13.

c. The plate of the oscillator tube is bypassed to ground for radiofrequencies by C23. Rf choke L4 provides a path for the dc cathode

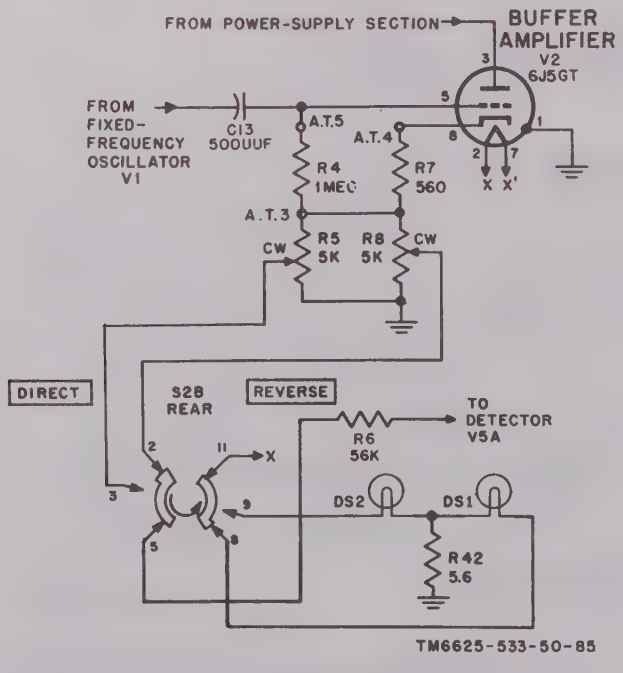


Figure 1–79. Buffer amplifier V2, schematic diagram.

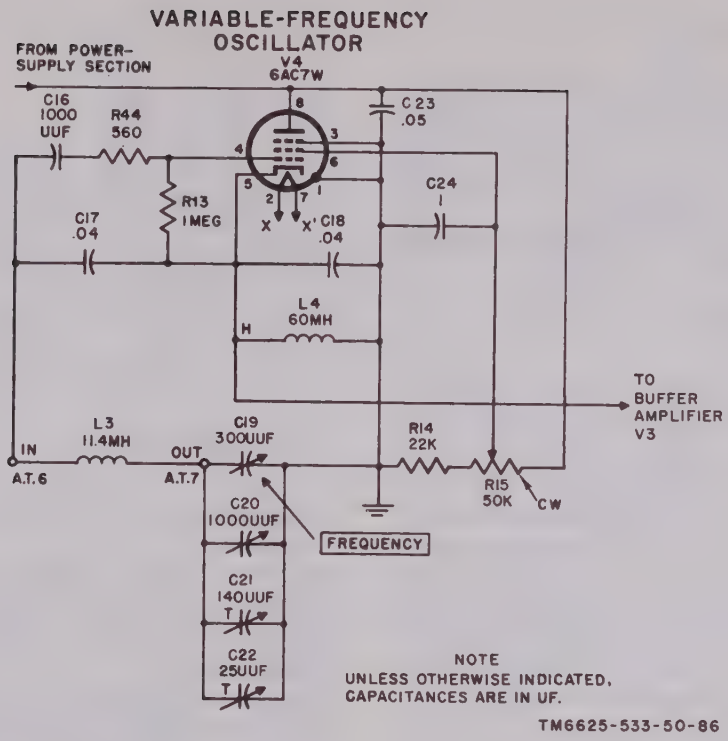


Figure 1–80. Variable-frequency oscillator V4, schematic diagram.

current of the tube.

d. The screen voltage for V4 is obtained from voltage dividers R14 and R15, bypassed by C24. Variable resistor R15 regulates the amplitude of oscillation.

e. Output from the oscillator is taken from the cathode across C18 and L4.

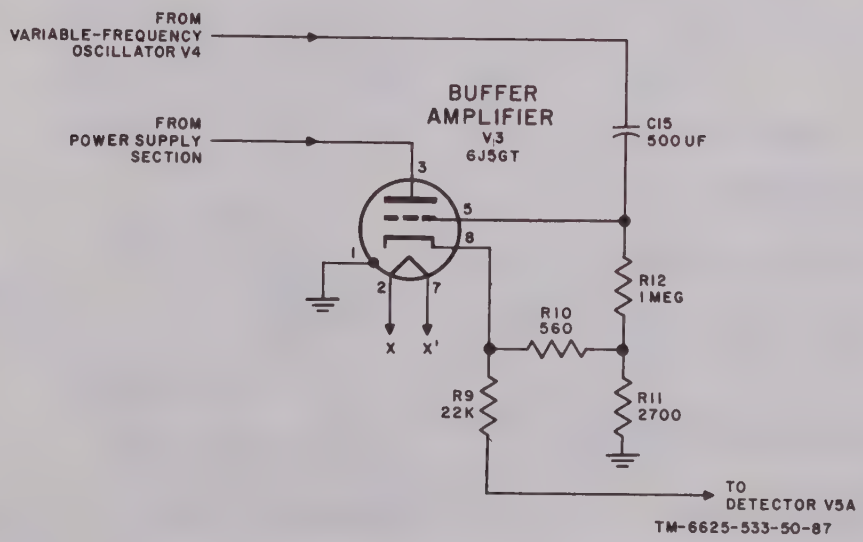


Figure 1–81. Buffer amplifier V3, schematic diagram.

1–79. Buffer Amplifier V3
(fig. 1–81)

a. The buffer amplifier is a cathode follower and is grid-coupled through C15 from variable-frequency oscillator V4. Output is taken from cathode resistors R10 and R11. Grid bias is provided by R10 through R12.

b. Output is coupled to detector V5A through isolating resistor R9.

1–80. Detector V5A
(fig. 1–82)

Detector V5A combines and detects the outputs of fixed and variable oscillators V1 and V4 to produce the 0– to 5,000-cycle signal used to identify the unknown audio beat notes. The input signals to the detector are coupled from buffer amplifiers V2 and V3 to common terminating resistor R17 and to the detector grid across capacitor C25. Grid-leak resistor R18 is used for detection. Output from the detector is across plate load resistor R19 through an rf filter circuit (fig. 1–83).

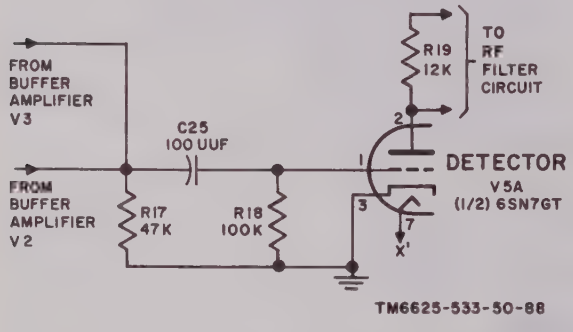


Figure 1–82. Detector V5A, schematic diagram.

1–81. RF Filter Circuit
(fig. 1–83)

a. The rf bandpass filter consists of L5, C26, C27, and C28.

b. The dc plate supply to detector V5A is through the decoupling filter of R21 and C29A.

c. The rf output from the filter is across terminating resistor R20 to mixer V6A.

1–82. Mixer V6A
(fig. 1–84)

a. The af input to mixer V6A is coupled

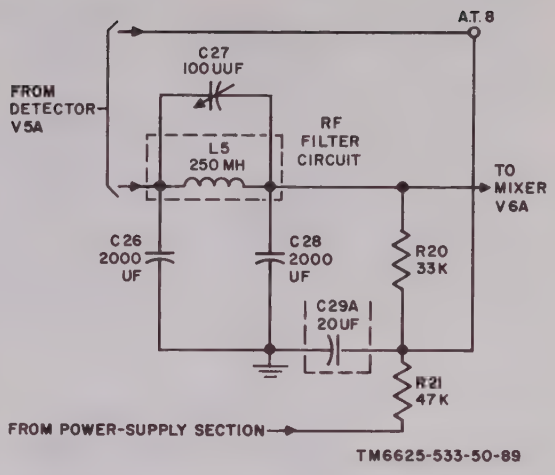


Figure 1–83. Rf filter circuit, schematic diagram.

from the rf filter through coupling capacitor C30 and resistors R22 and R23. Variable resistor R22 is used to adjust the input level to the mixer.

b. The audiofrequency to be measured is fed into V6A cathode circuit across R24 through coupling capacitor C38 from input amplifier V7.

c. The dc plate supply for V6A is applied through the decoupling filter consisting of R26 and C29B. The audiofrequency output V6A is taken across plate load resistor R25.

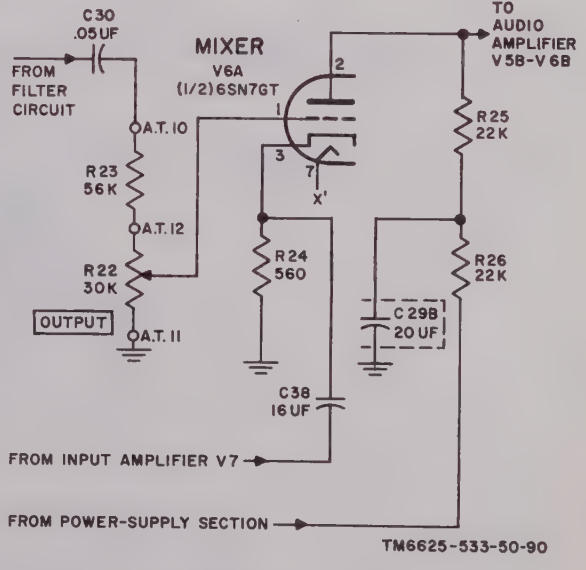


Figure 1–84. Mixer V6A, schematic diagram.

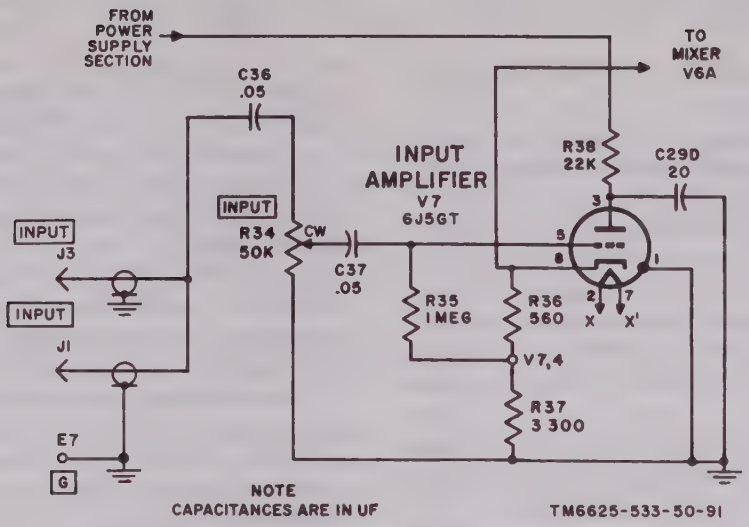


Figure 1–85. Input amplifier V7, schematic diagram.

1–83. Input Amplifier V7
(fig. 1–85)

a. Input amplifier V7 is used to couple audiofrequency signals from an external source, regardless of its impedance, to mixer V6A. The external signal can be connected to the amplifier either at INPUT jack J1, on the front panel, or J3 at the rear of the unit.

b. The input signal is coupled to amplifier V7 by capacitor C36, volume control R34, and coupling capacitor C37.

c. The dc plate voltage is supplied through the decoupling filter of R38 and C29D.

d. The output of V7 is taken from cathode resistors R36 and R37. Bias is provided by R36 through grid-leak resistor R35.

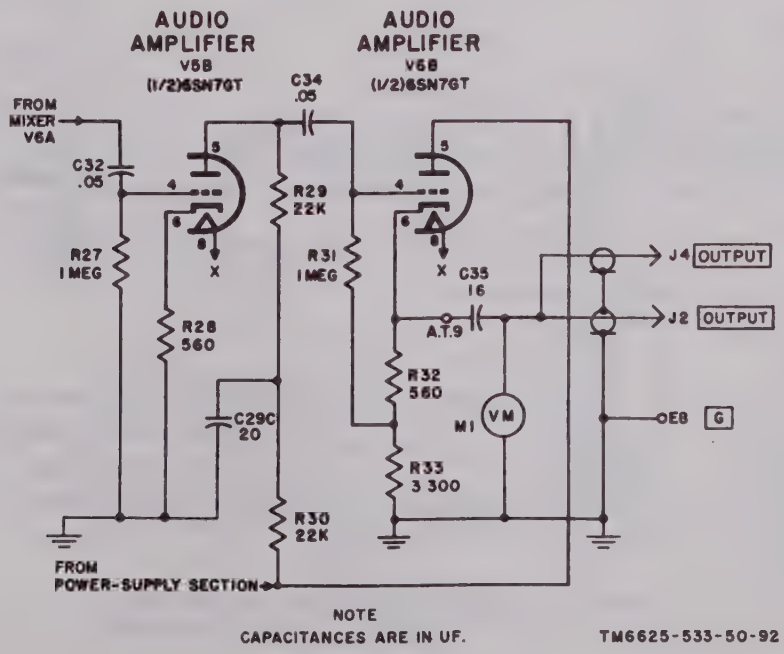


Figure 1–86. Audio amplifiers V5B and V6B, schematic diagram.

1–84. Audio Amplifiers V5B and V6B (fig. 1–86)

a. The audio amplifiers consist of V5B and V6B.

b. The audiofrequency voltage from mixer V6A is applied to V5B through coupling capacitor C32. Cathode resistor R28 and grid resistor R27 provide bias for V5B. Cathode resistor R28 is not bypassed; therefore, some degeneration is supplied to improve the linearity of the amplifier. Audio amplifier V5B plate voltage is supplied from a decoupling filter consisting of R30 and C29C and plate load resistor R29.

c. The output from V5B is taken across plate load resistor R29 and is coupled to the input of V6B through coupling capacitor C34.

d. The output from V6B (cathode follower) is taken across cathode resistors R32 and R33 through coupling capacitor C35, to OUTPUT meter M1 and OUTPUT jacks J2 (on front panel) and J4 (on rear of equipment). The grid return to ground is resistors R31 and R33.

1–85. Power Supply Section (fig. 1–87)

a. The power supply section includes power transformer T1; rectifier V8; filter consisting of C42, C43, C44, R39, R40, and R41; regulator series resistor R16; and voltage regulator V9. The line power is supplied to T1 transformer primary windings through power jack J5; rf filter consisting of C40 and C41, fuses F1 and F2, and switch S1. For 115-volt operation, the primary windings of T1 are connected in parallel; for 230-volt operation, the primary windings of T1 are connected in series.

b. The power supply steps up the line voltage, rectifies and filters it to produce dc plate and screen voltages. The power supply also steps down a portion of the line voltage for the filaments of the tubes.

c. The pulsating dc voltage from full-wave rectifier V8 is filtered by the rc filter consisting of R39, C42, R40, C43, R41, and C44. A regulated voltage is provided for V1 and V4 plates by regulator tube V9 through regulator series resistor R16.

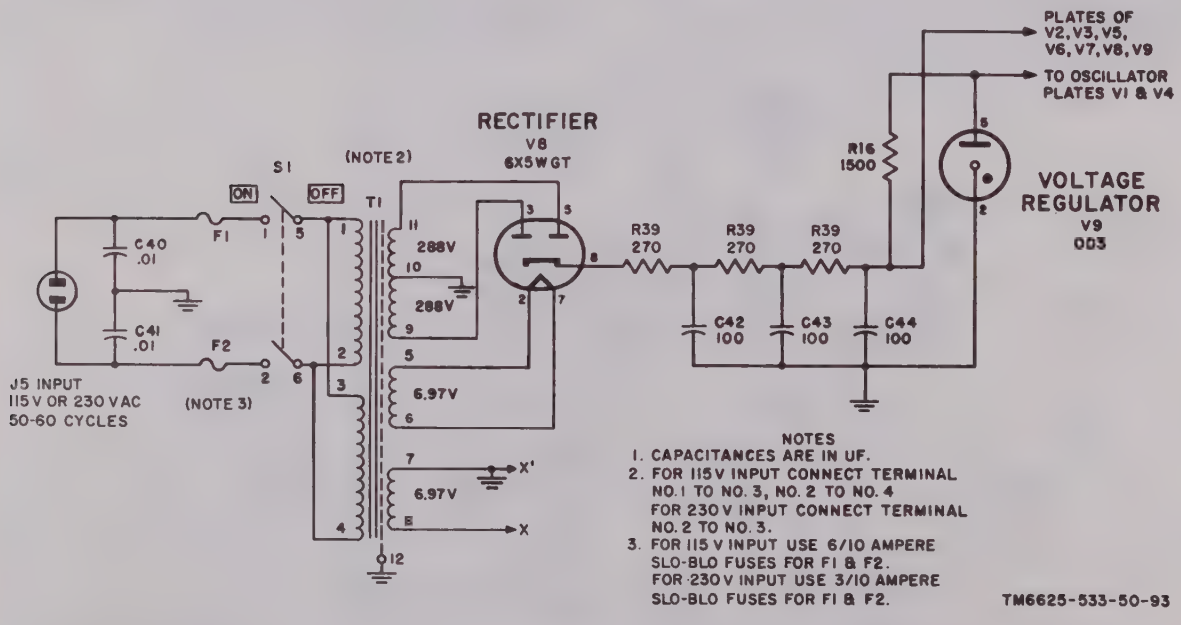


Figure 1–87. Power supply section, schematic diagram.

1–86. Oscilloscope OS–16A/URM–18 Block Diagram (fig. 1–88)

a. Oscilloscope OS–16A/URM–18 is designed to rapidly and accurately compare frequencies. The oscilloscope consists of CIRCULAR SWEEP FREQUENCY selector switch S1; selective amplifiers; SELECTOR switch S2; vertical, horizontal, and radial amplifiers; cathode-ray tube V5, and a power supply section. The schematic diagram of the unit is shown in figure 4–11.

b. CIRCULAR SWEEP FREQUENCY selector switch S1 permits the selection of any one of five known frequencies. The LINE position of S1 gives the frequency of the input power to the unit. The 100 ∼ , the 1 kc, and the 10 kc positions of S1 give standard frequencies and the INTERP. OSC. position gives a variable-frequency signal that is obtained from Generator, Signal SG–42/URM–18. The selected fixed frequency is fed into selective amplifier stage V1; then, either the fixed or variable frequencies are coupled through amplifier stage V2 and the phase shifter. The outputs of the phase shifter are coupled to the horizontal and vertical amplifiers and then to cathode-ray tube V5 to produce a circular sweep trace on the face of the tube. Through the use of SELECTOR switch S2, the selection of any pair of frequency sources may be compared. Of the selected pair of frequencies to be compared, the standard or reference frequency produces the circular sweep or is placed on the horizontal deflection plates of the cathode-ray oscilloscope; the unknown frequency or the frequency to be compared is placed on the radial deflection electrode, or on the vertical deflection plates of the cathode-ray tube V5.

1–87. Amplifier Gain Control (DIAMETER) and Tuned Amplifier V1 (fig. 1–89)

a. The signal voltage selected by CIRCULAR SWEEP FREQUENCY switch S1 is filtered to improve the waveform, by the resistance-capacitance filter consisting of R1 in series with

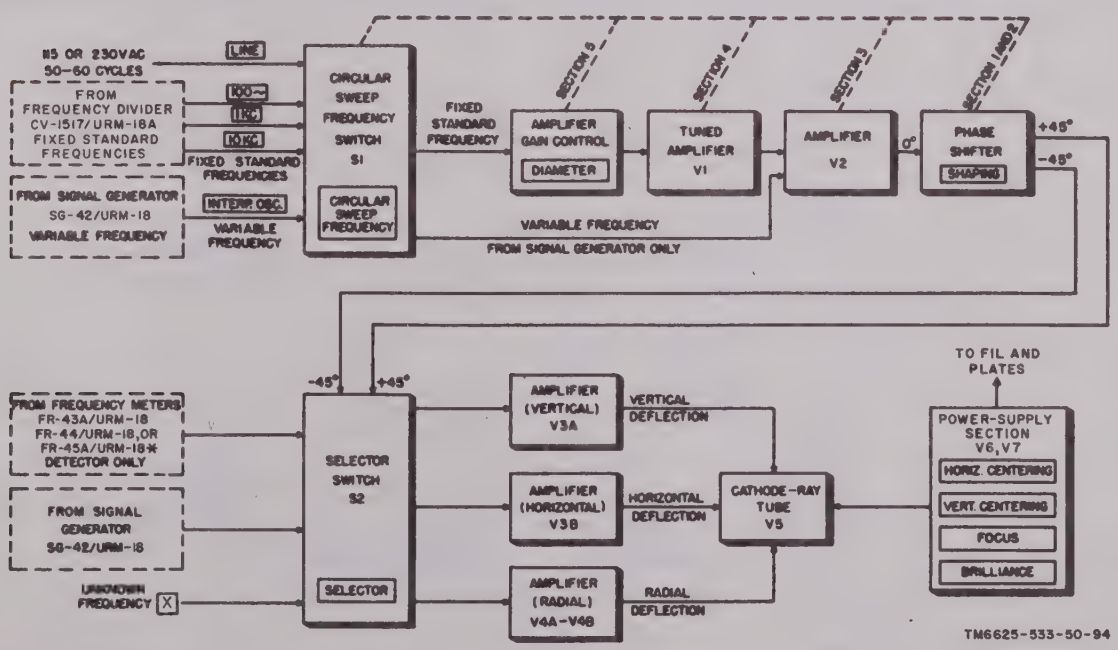


Figure 1–88. Oscilloscope OS–16A/URM–18, block diagram.

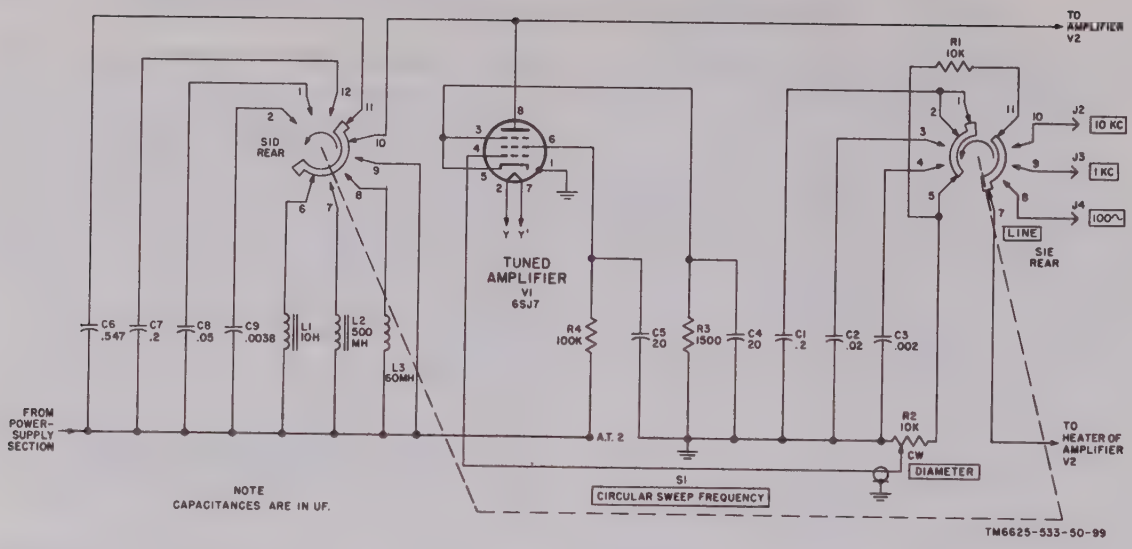


Figure 1–89. Amplifier gain control (DIAMETER) and tuned amplifier V1, schematic diagram.

capacitor C1, C2, or C3 selected by S1E. The filtered output is taken across the capacitor (C1, C2, or C3) by potentiometer R2, which controls the diameter of the circular sweep, and is applied to the grid of tuned amplifier V1.

b. The output circuit of amplifier V1 is tuned for each selected input frequency by inductors L1, L2, and L3 and capacitors C6, C7, C8, and C9 selected by S1D. This tuning improves the waveworm so that a less distorted circular sweep is obtained.

c. The output of tuned amplifier V1 is taken across the tuned circuit selected by S1D and is fed to the input of amplifier V2.

d. Filament and plate voltage for V1 is obtained from the power supply section.

1–88. Amplifier V2
(fig. 1–90)

a. Amplifier V2 is a cathode follower used to prevent reaction on tuned amplifier V1 and to step down from the high impedance of the tuned circuit to the low impedance of the phase shifter (para 1–89).

b. The input signal voltage for V2 is obtained either from tuned amplifier V1 or from Generator, Signal SG–42/URM–18 (INTERP. OSC. jack J5), as selected by CIRCULAR SWEEP FREQUENCY switch S1. This signal voltage is coupled to the grid of V2 through coupling capacitor C10.

c. The output of V2 is taken across cathode resistor R6 and R7 and coupled to the phase shifter through coupling capacitor C11.

d. Grid return to ground is through R5 and R7.

e. Heater and plate voltage for V2 is obtained from the power supply section.

1–89. Phase Shifter
(fig. 1–91)

a. The phase shifter consists of two parallel branches of resistors and capacitors in series. In one branch, the capacitor is grounded and in the other, the resistor is grounded. Two resistors in the first branch, R9 and R10, are adjustable and provide an adjustment for overcoming component tolerances. Resistor R9 adjusts in the LINE, 100 ~, and 1 kc positions of S1 and R10 in INTERP. OSC. position of S1. The output signal voltage of the first branch is taken across capacitor C12, C13, C14, C15, or C16 as selected by S1. This signal voltage lags the output signal voltage of amplifier V2 by 45 degrees.

b. Resistor R11 of the second branch is fixed, but a sliding tap is provided so that the output signal voltage can be adjusted in magnitude to

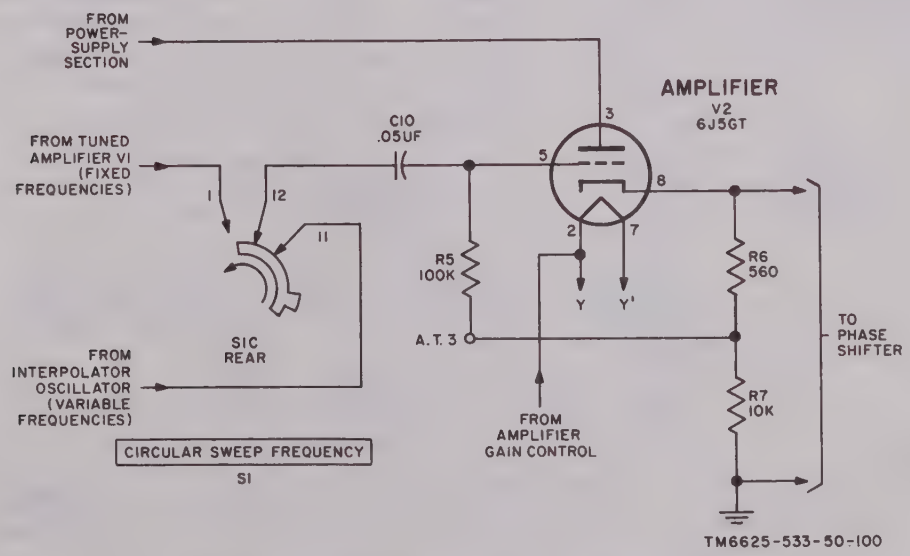


Figure 1–90. Amplifier V2, schematic diagram.

vary the shape of the circular sweep. This adjustment (R11) is marked SHAPING. The capacitor used, C17, C18, C19, C20, or C21, is selected by the setting of S1. The output signal voltage taken off at the top of R11 of this branch leads the output signal voltage of amplifier V2 by 45 degrees.

c. The SHAPING adjustment provides for overcoming inequalities of the two deflection voltages due to component tolerances, differences in gain of the horizontal and vertical deflection amplifiers, and the inherent difference in sensitivity of the horizontal and vertical deflection plates of cathode-ray tube V5.

1–90. SELECTOR Switch S2 (fig. 1–92)

a. SELECTOR switch S2 connects radial amplifier V4A into the circuit when circular sweeps are used and removes it when Lissajous patterns are employed.

b. In the first position of S2 (fully conterclockwise DET.-INTERP.), Generator, Signal SG–42/URM–18 is connected from J5 to the horizontal deflection system, and the detector output (of the frequency meter in use) is connected to the vertical deflection system.

c. In the next three positions of S2, the radial amplifier is connected, in turn, to Generator, Signal SG–42/URM–18, the detector output, and the X terminals on the panel. In each case, the circular sweep voltage from the phase shifter, as selected by the CIRCULAR SWEEP FREQUENCY switch, is fed to the horizontal and vertical amplifiers.

d. In the fifth position of S2 (X-INTERP. CIRC. SW), the radial amplifier remains connected to the X terminal on the panel and the circular sweep frequency is chosen by the CIRCULAR SWEEP FREQUENCY switch. This

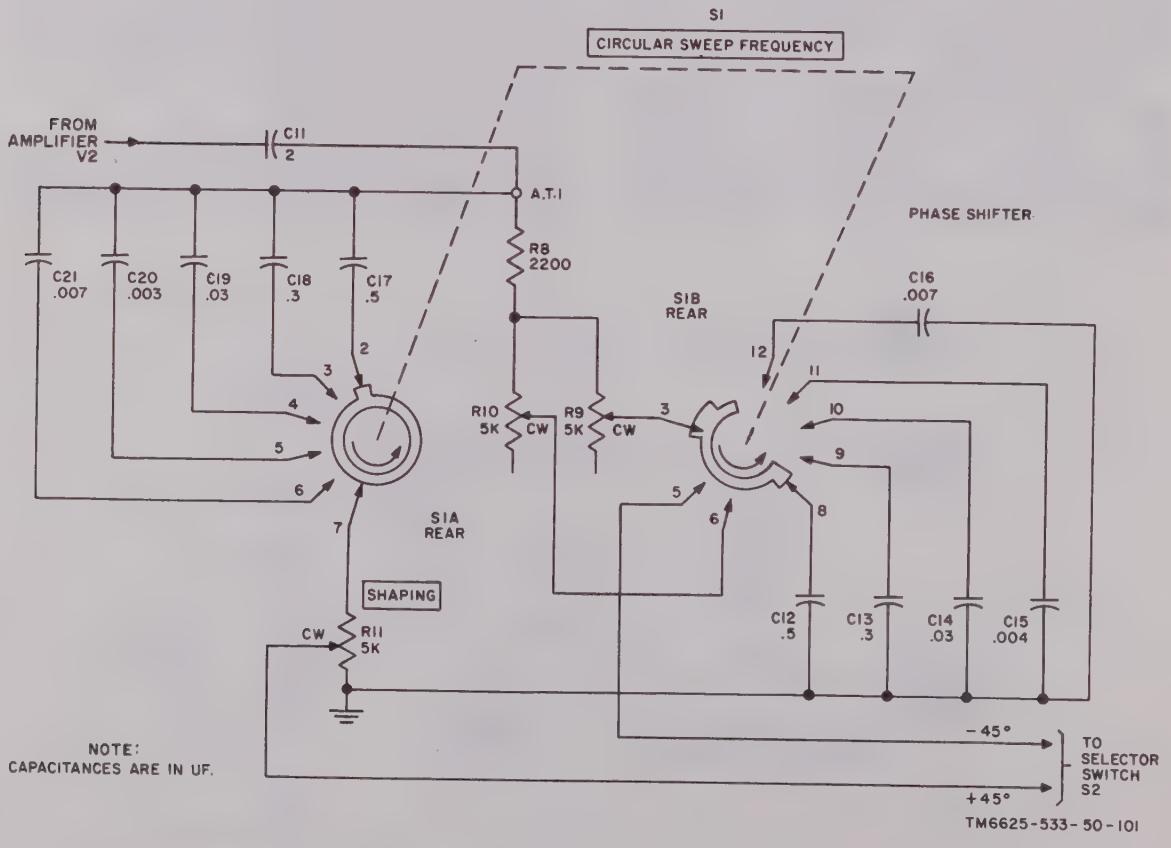


Figure 1–91. Phase shifter, schematic diagram.

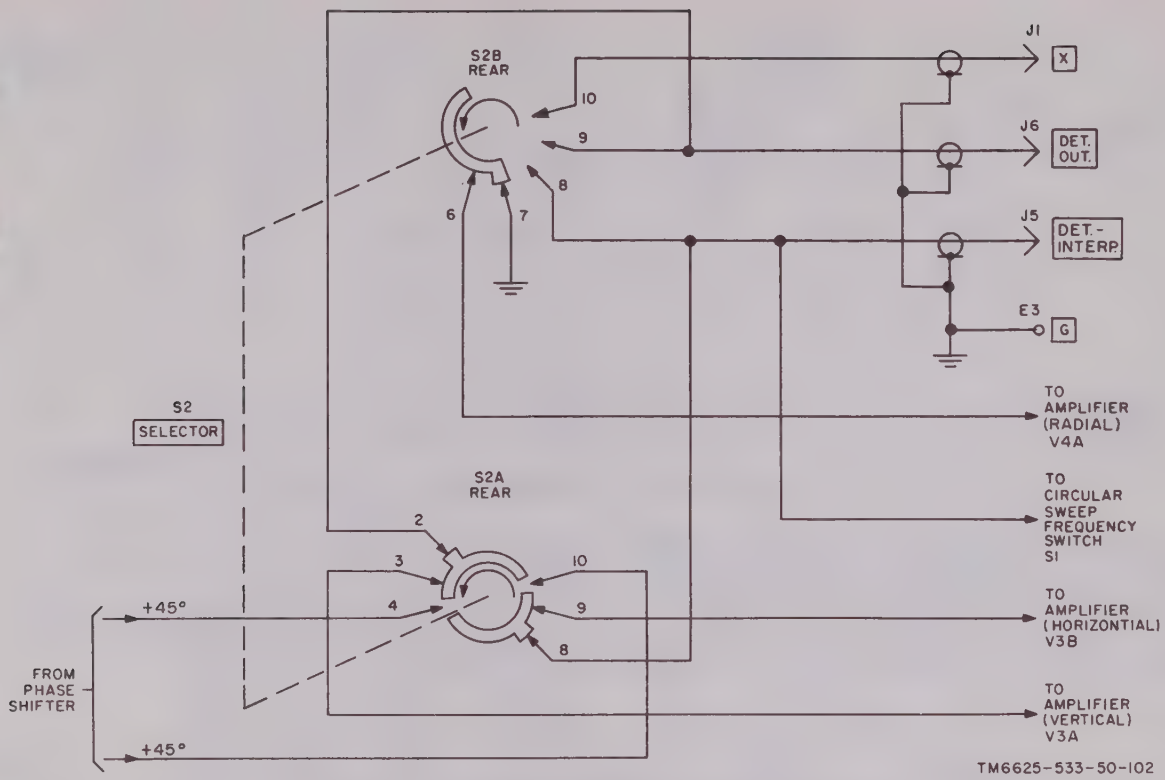


Figure 1–92. SELECTOR switch S2, schematic diagram.

position is of no significance, since it duplicates the X-STD. CIRC. SW position.

1–91. Vertical Amplifier V3A
(fig. 1–93)

Vertical amplifier V3A and horizontal amplifier V3B are identical. The vertical amplifier is described below.

a. Vertical amplifier V3A is a degenerated transformer-coupled stage. The input signal voltage is applied to the grid of V3A through coupling capacitor C22. Bias is obtained from

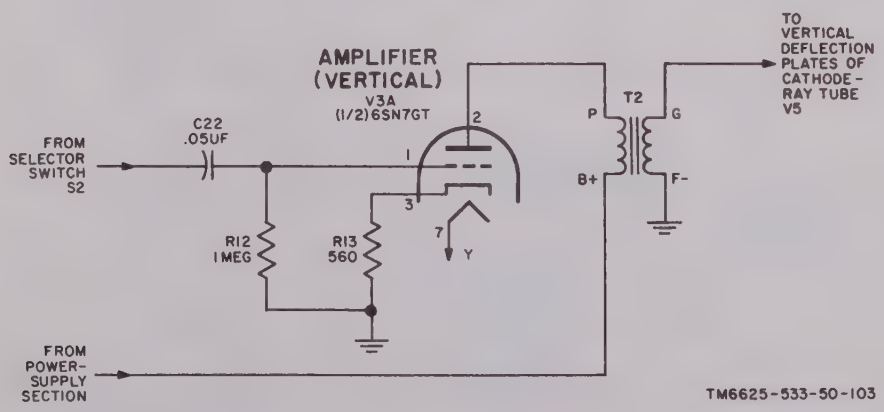


Figure 1–93. Vertical amplifier V3A, schematic diagram.

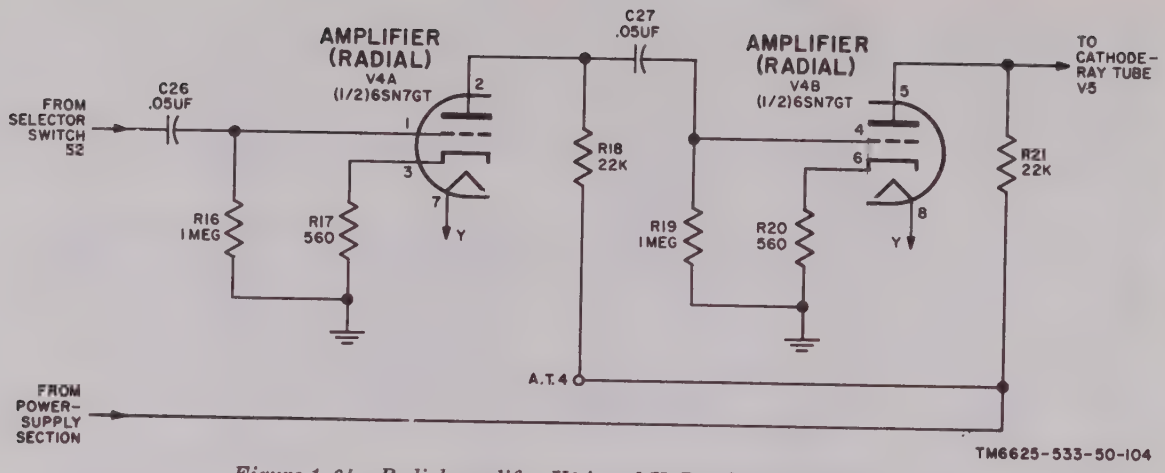


Figure 1–94. Radial amplifier V4A and V4B, schematic diagram.

cathode resistor R13 and grid-leak resistor R12. Since R13 is unbypassed, degeneration helps to reduce distortion in this stage.

b. The vertical amplifier output signal voltage is stepped up by transformer T2 to drive the vertical deflection plates of cathode-ray tube V5.

c. Plate and filament voltages for vertical amplifier V3A are obtained from the power supply section.

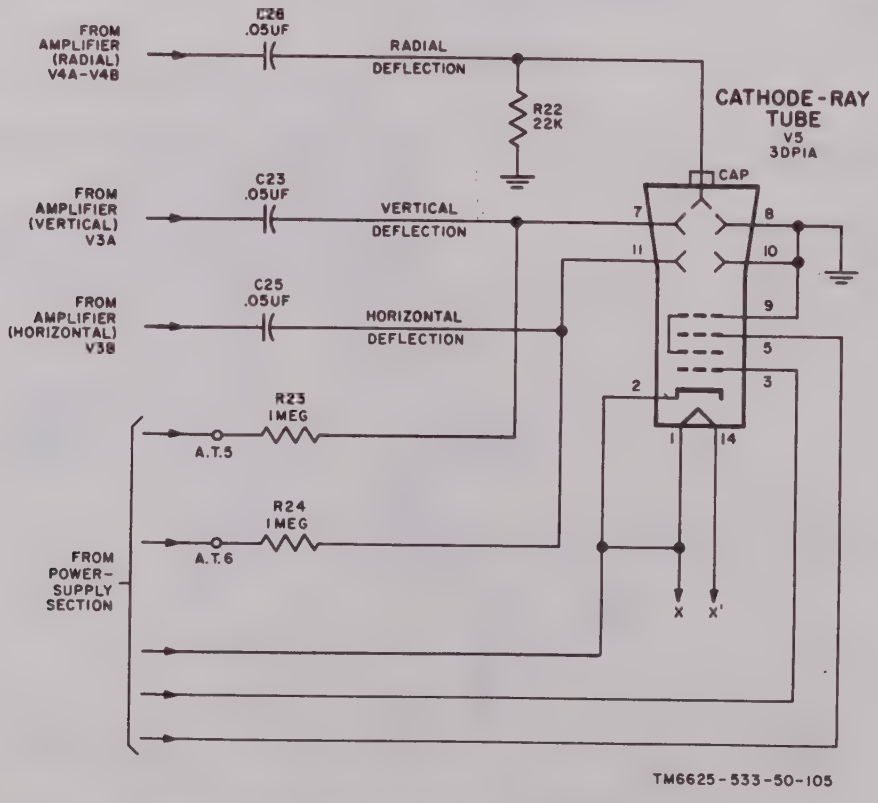


Figure 1–95. Cathode-ray tube V5, schematic diagram.

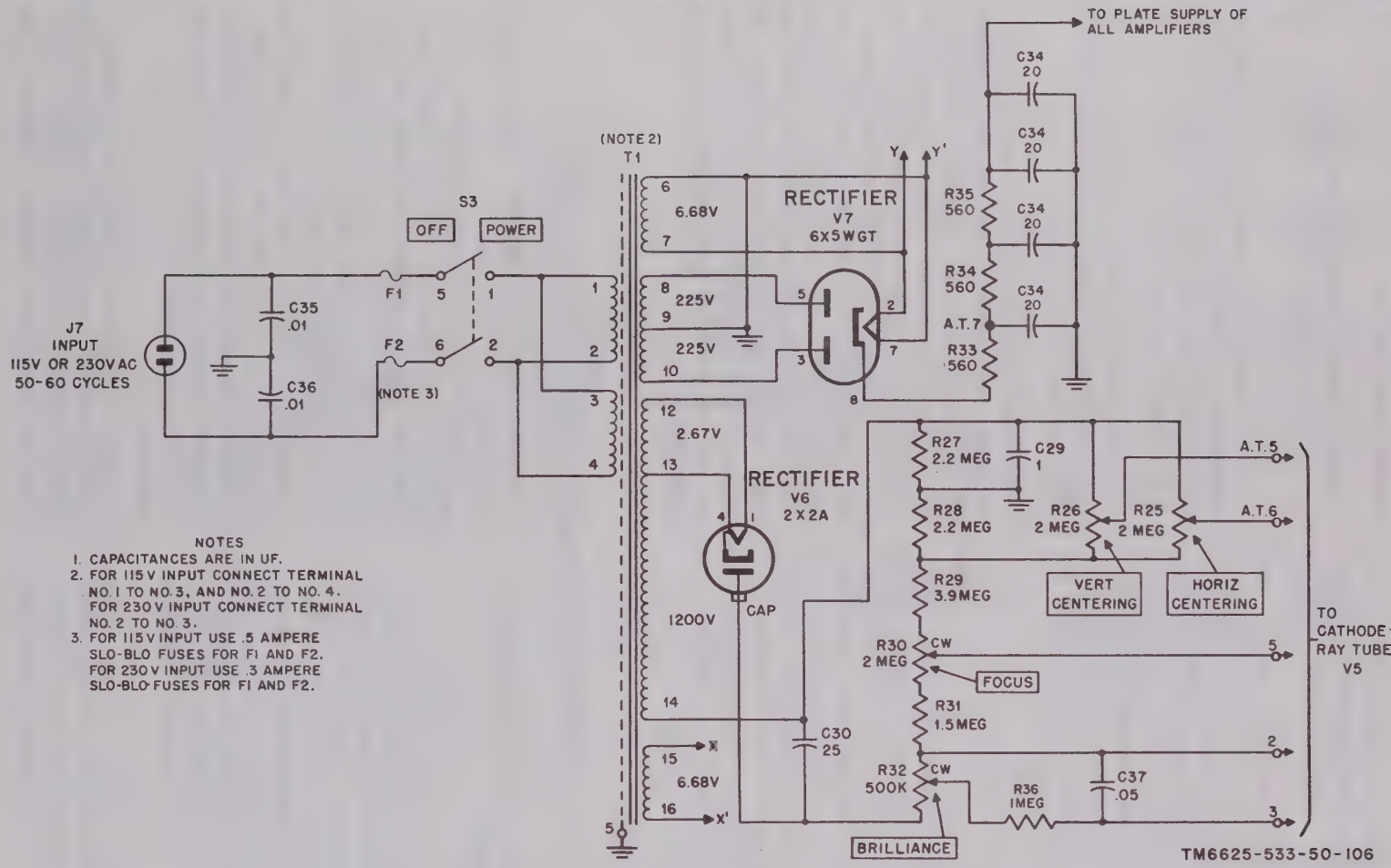


Figure 1–96. Power supply section, schematic diagram.

1–92. Radial Amplifier V4A and V4B (fig. 1–94)

a. The radial deflection amplifier V4A and V4B, is a two-stage resistance-capacitance-coupled degenerated amplifier with identical stages.

b. The input signal to each stage is fed through coupling capacitor C26 for V4A and C27 for V4B. Cathode resistor for V4A is R17 and R20 for V4B. Grid return to ground is R16 for V4A and R19 for V4B. Since the cathode resistors are not bypassed, there is degeneration. The output signal voltage is taken across plate load resistor R21 and coupled to the radial deflection element of V5.

1–93. Cathode-Ray Tube V5 (fig. 1–95)

a. The input signal voltages to the three deflection elements are applied through coupling capacitors C28 for radial, C23 for vertical, and C25 for horizontal. For the radial deflection, leak resistor R22 is returned to ground. For the horizontal and vertical deflection circuits, the leak resistors are returned to sources of adjustable dc bias through R25 and R26 for positioning of the pattern on the face of cathode-ray tube V5.

b. All electrode and filament voltages for cathode-ray tube V5 are supplied from the power supply section.

1–94. Power Supply Section (OS–16A/URM–18) (fig. 1–96)

a. Line power is supplied to the primary of transformer T1 through the rf filter consisting of C35 and C36, line fuses F1 and F2, and POWER-OFF switch S3.

b. The primary windings of transformer T1 are connected in parallel for 115-volt operation and in series for 230 volts.

c. Transformer T1 supplies two high-voltage windings for rectifiers V7 and V6. Rectifier V7 supplies voltage to the filter (R33, R34, R35, C31, C32, C33, and C34) for use as plate voltage of all amplifier tubes of the unit. Rectifier V6, filtered by C30, supplies voltage to the electrodes of cathode-ray tube V5. Resistors R27, R28, R29, and R31, in conjunction with the variable resistors R25, R26, R30, and R32, provide voltage taps for horizontal centering, vertical centering, focus, and brilliance of the waveform pattern on the cathode-ray tube screen.

Section VIII. FUNCTIONING OF PANEL, CONTROL SB–105A/URM–18

1–95. Panel, Control SB–105A/URM–18 Block Diagram (fig. 1–97)

The routing and switching of signal flow within and without the calibrator set is the primary function of the control panel. This unit also generates harmonics from the 10-kc and 100-kc standard frequency outputs of the standard frequency divider. Signal paths and major functional sections of the unit are shown in the block diagram (fig. 1–97) and are discussed in *a* through *k* below. For complete circuit details, refer to the overall schematic diagram (fig. 4–12).

a. 100-Kc Blocking Oscillator. The 100-kc blocking oscillator receives the 100-kc standard frequency square-wave output of the standard frequency divider and produces a 100-kc trigger pulse which is applied to the 100-kc pulse generator.

b. 100-Kc Pulse Generator. The 100-kc pulse generator receives the 100-kc trigger pulse from the 100-kc blocking oscillator and generates harmonics of the 100-kc standard frequency that are applied through the high-pass filter to DETECTOR switch S104.

c. 10-Kc Blocking Oscillator. The 10-kc blocking oscillator receives the 10-kc standard frequency square-wave output of the standard frequency divider and produces a 10-kc trigger pulse which is applied to the 10-kc pulse generator.

d. 10-Kc Generator. The 10-kc pulse generator receives 10-kc trigger pulse from the 10-kc blocking oscillator and generates harmonics of the 10-kc standard frequency that

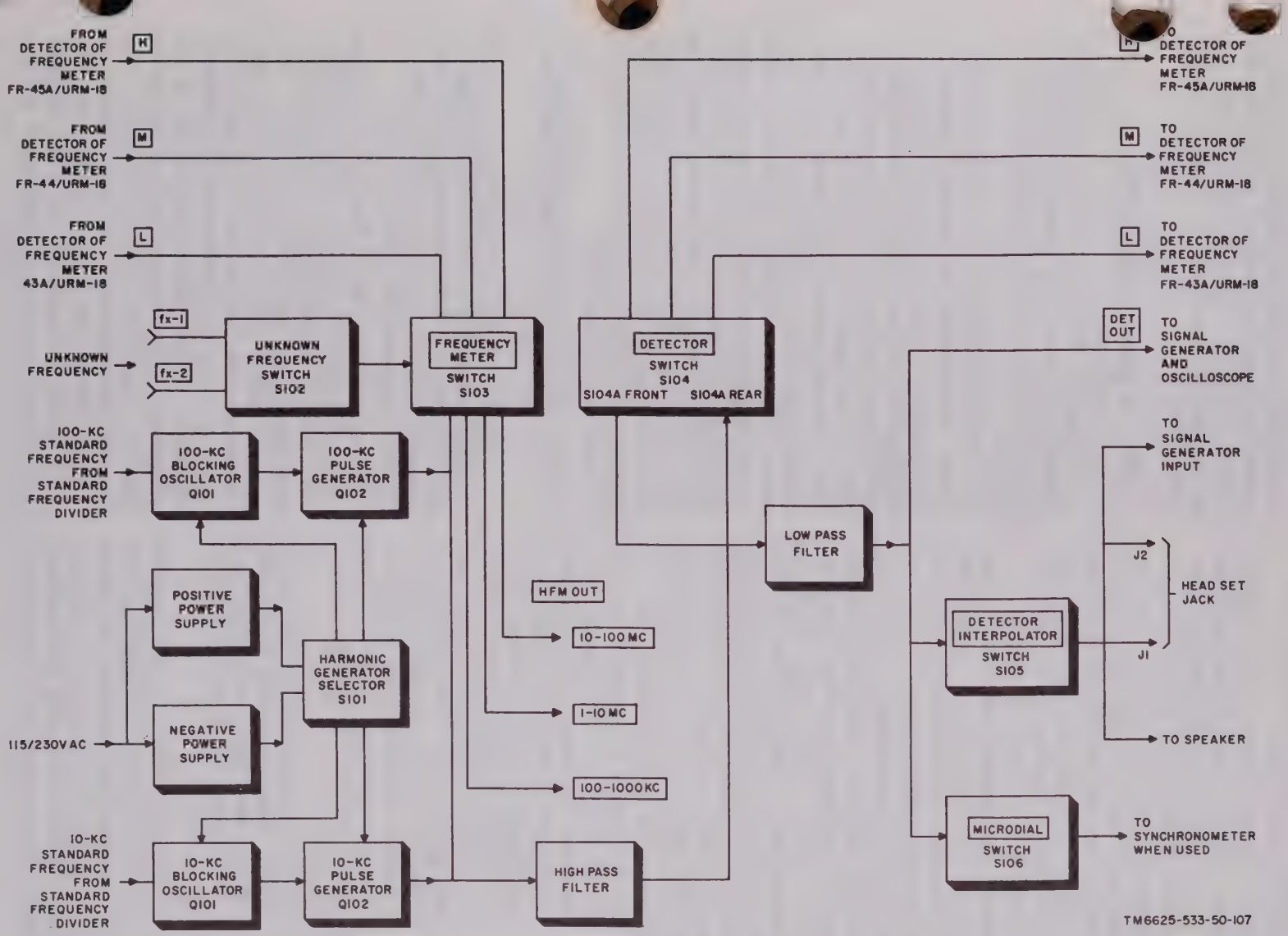


Figure 1–97. Panel, Control SB–105A/URM–18, showing interconnections to frequency standard and measuring units, block diagram.

are then applied through the high-pass filter to DETECTOR switch S104.

e. Positive Power Supply. The positive power supply receives the 115-vac input and applies +114.5-vdc through harmonic generator selector switch S101 to the 10-kc and 100-kc pulse generators.

f. Negative Power Supply. The negative power supply receives the 115-vac input and applies −6 vdc through harmonic generator selector switch S101 to the 100-kc and 10-kc blocking oscillators and pulse generators.

g. Unknown Frequency Switch S102. Unknown frequency switch S102 applies the unknown frequency to S103 and through the high-pass filter to switch S104.

h. FREQUENCY METER Switch S103. The FREQUENCY METER switch S103 applies the outputs of the three frequency meters to DETECTOR switch S104. The frequency meters outputs also bypass S103 and are applied directly to the front panel output jacks (H. F. M. OUT, 10-100 MC, 1-10 MC, and 100-1000 KC).

i. DETECTOR Switch S104. DETECTOR switch S104 has two functions as follows:

(1) The application of signals to the frequency meters detectors inputs. The unknown frequency or frequencies from unknown frequency switch S102, the frequency meter output from FREQUENCY METER switch S103, the 100-kc standard frequency harmonics from the 100-kc pulse generator and the 10-kc standard frequency harmonics from the 10-kc pulse generator are applied to the inputs of the frequency meters detectors.

(2) The application of the frequency meters detectors outputs to the signal generator and oscilloscope and to DETECTOR-INTERPOLATOR switch S105.

j. DETECTOR-INTERPOLATOR Switch S105. The DETECTOR INTERPOLATOR switch S105 receives the output of the signal generator and the frequency meter detector output from DETECTOR switch S104 and applies either of these signals to the loudspeaker.

k. MICRODIAL Switch S106. MICRODIAL switch S106 receives the output of the signal generator and the frequency meter detector output from DETECTOR switch S104 and applies either of these signals to a sychronometer when used.

1—96. Fx Selector Switch S102

(fig. 1–98)

a. General. The fx selector switch S102 is placed in the circuit of ground, fx-1, fx-2, or both fx-1 and fx-2, depending upon the position of S102.

b. Detailed Operation. In the first position (fully counterclockwise) ground is applied to the contacts of 10 and 6 of S102 to R109, out of the movable contacts of R109 to FREQUENCY METER switch S103. When in the next switch position, the input of J6 (fx-1) is applied to S102 through contact 1. Contact 6 then couples the signal to FREQUENCY METER switch S103 through R109. When in the next switch the input of J13 (fx-2) is applied to contact 8 of S102, to contact 6 to R109, and to FREQUENCY METER switch S103. The fully clockwise position of the switch permits fx-1 and fx-2 to be connected together and coupled to FREQUENCY METER switch S103 through contact 6 and R109.

1—97. 10-Kc or 100-Kc Blocking Oscillator

(fig. 1–99)

a. General. The negative pulse (10-kc and 100-kc) output from the standard frequency divider is applied to the blocking oscillator and the positive pulse output is applied to 10-kc or 100-kc pulse generator Q102.

b. Detailed Operation. The 10-kc or 100-kc signal is applied to the base of Q101 through the matching network of C101 and R101, C102 and R102, and the primary of T101. The negative pulses applied to the base of Q101 transistor cause W101 to conduct to saturation. Current flow in the output circuit, which is the secondary of T101, causes the junction of the secondary and the collector of Q101 to become positive. Conduction continues as long as the negative pulse appears on the base. When conduction ceases, the magnetic field that had built up in the secondary to T101 collapses and induces a regenerative feedback in the pri-

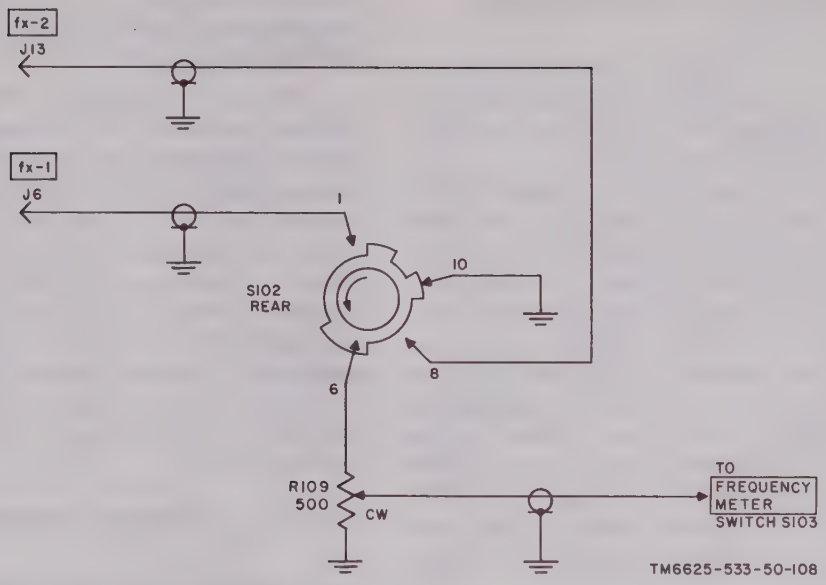


Figure 1–98. Fx selector switch S102 and fx control R109, schematic diagram.

mary of T101. This causes an additional current flow through Q101. Diode CR101 is used to protect Q101 against reverse current flow. Resistor R102 is a base return resistor. Collector supply voltage is applied to the collector of Q101 through the secondary of T101.

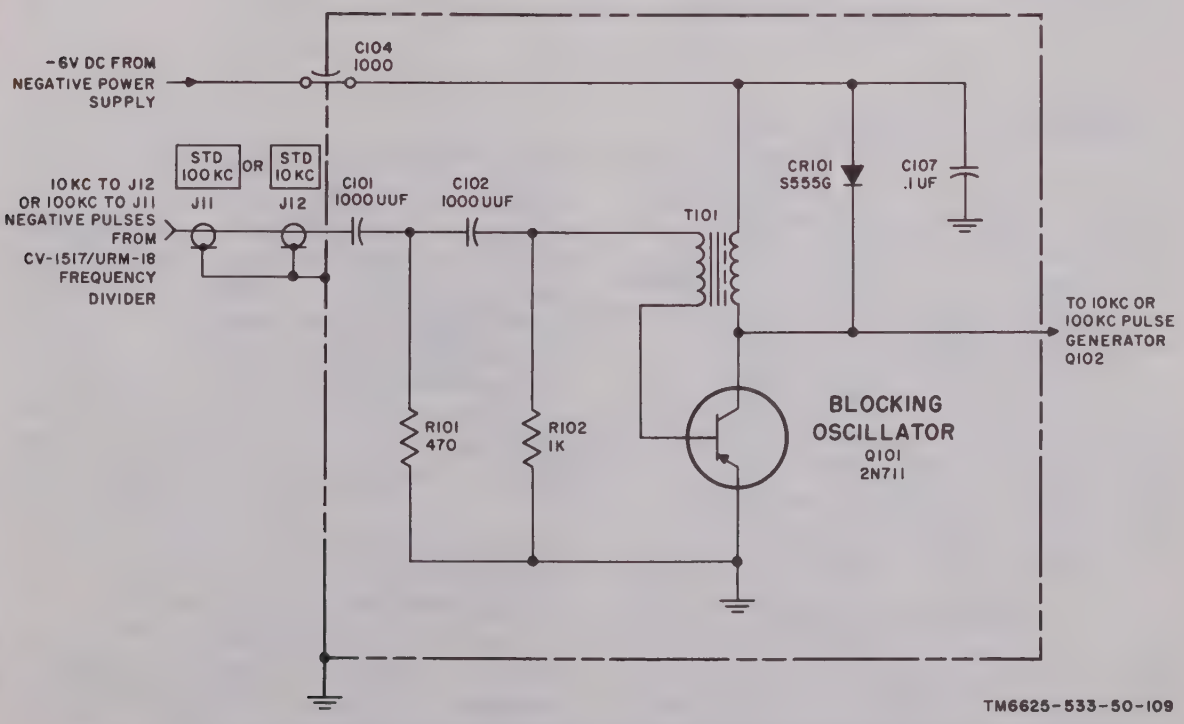


Figure 1–99. Blocking oscillator Q101 for 10-kc and 100-kc harmonic generators, schematic diagram.

1–98. 100-Kc Pulse Generator Q102 (fig. 1–100)

a. General. The positive pulse of Q102 output of blocking oscillator Q101 is applied to Q102 and the output of Q102 is fed to FREQUENCY METER switch S103.

b. Detailed Operation. The output from blocking oscillator Q101 is applied to the base of Q102 through coupling capacitor C103. The output, taken off the collector of Q102, is coupled by C105 through the parasitic suppressing network consisting of R111 and L3, to voltage-dividing network R106 and R112 to S103. Bias for the base of Q102 is supplied by the negative power supply and applied to the voltage-dividing network consisting of R104 and R103. Collector supply voltage for Q102 is supplied by the positive power supply and applied to the collector through dropping resistor R105.

1–99. 10-Kc Pulse Generator Q102 (fig. 1–101)

a. General. The positive pulse output of blocking oscillator Q101 is applied to Q102 and the output of Q102 is fed to FREQUENCY METER switch S103.

b. Detailed Operation. The output from blocking oscillator Q101 is applied to the base of Q102 through coupling capacitor C103. The output, taken off the collector of Q102, is coupled by C105 to the voltage-dividing network consisting of R106 and R112 to S103. Bias for the base of Q102 is supplied by the negative power supply and applied to the voltage-dividing network consisting of R104 and R103. Collector supply voltage for Q102 is supplied by the positive power supply and applied to the collector through dropping resistor R105.

1–100. FREQUENCY METER Switch S103 (fig. 1–102)

a. General. The output signals of the low-frequency, medium-frequency, and high-frequency meters are combined with the unknown frequency and the outputs of the 10-kc and 100-kc pulse generators and applied to DE-

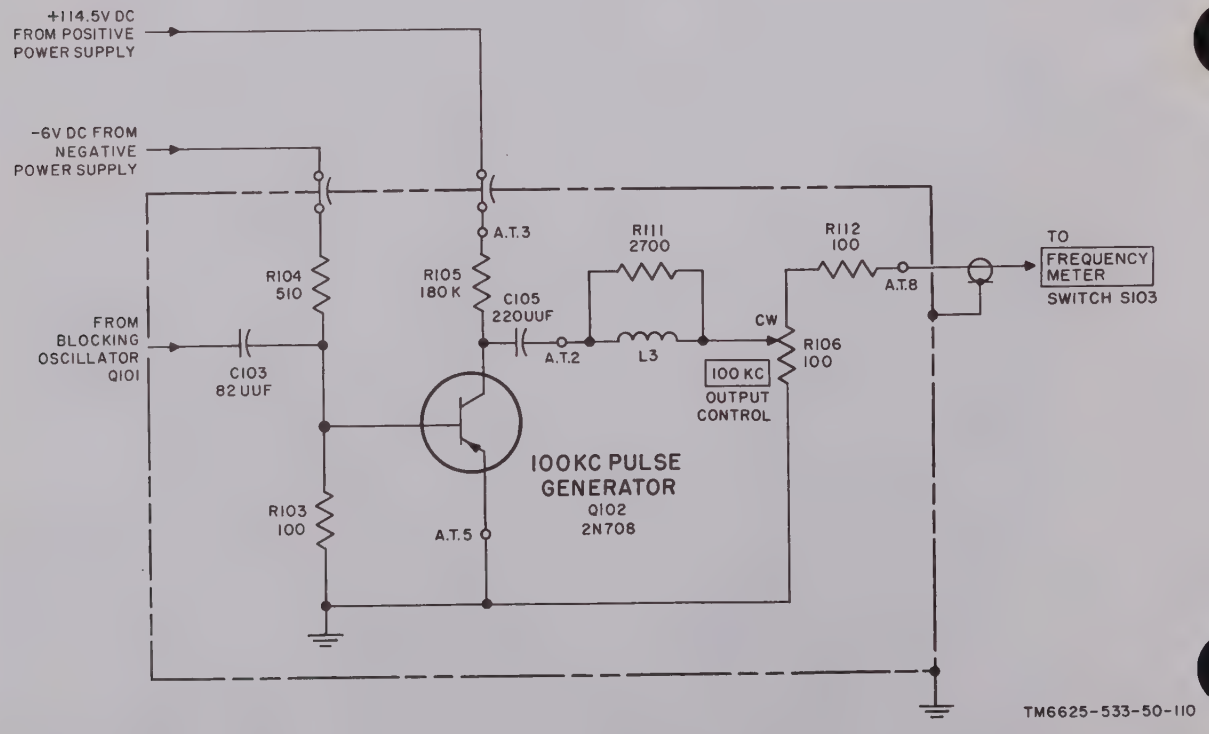


Figure 1–100. 100-kc pulse generator Q102, schematic diagram.

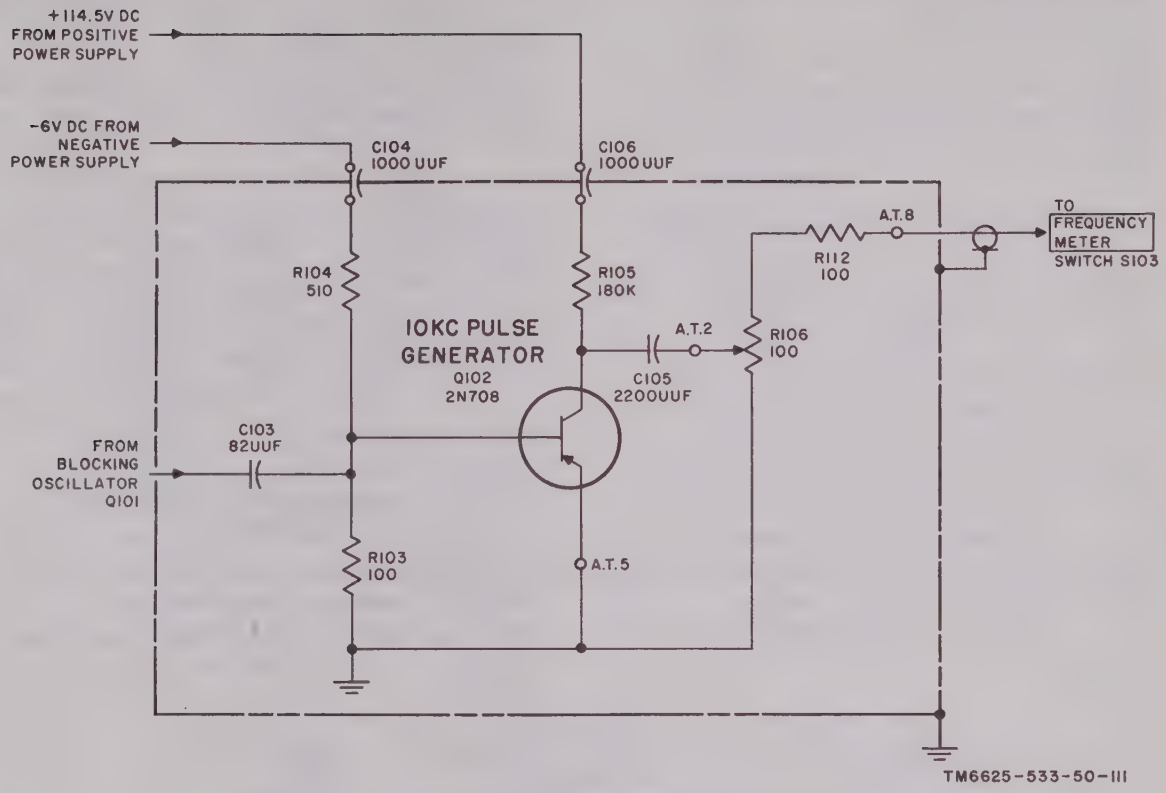


Figure 1–101. 10-kc pulse generator Q102, schematic diagram.

TECTOR switch S104.

b. Detailed Operation. Signals from the unknown frequency switch S102 are applied through fx control R109, R110, and R107. These signals are combined with the outputs of the 10-kc and 100-kc pulse generators and applied to an impedance-matching network comprised of C2, C3, and L2. The output of this network is fed to DETECTOR switch S104. The frequency meter output contact 12 is applied to the junction of R110 and R107. The operation of the FREQUENCY METER switch S103 is as follows:

(1) *L position.* The output of the low-frequency meter is applied to J5, located on the front panel, and contact 1 read section of S103.

(2) *M position.* The output of the medium-frequency meter is applied to J4, located on the front panel, and contact 2, front and rear sections of S103.

(3) *H position.* The output of the high-frequency meter is applied to contact 3, front and rear sections of S103.

(4) *L-M position.* The output of the low-frequency and medium-frequency meters are combined through the front and rear sections of S103.

(5) *M-H position.* The output of the medium-frequency and high-frequency are combined through the front and rear sections of S103. Jack J8 (H-2) is connected directly to J3 (10-100 MC) located on the front panel.

1–101. DETECTOR Switch S104 (fig. 1–103)

a. General. The output signals at the STANDARD FREQUENCY HARMONICS switch S101, switch S201, and FREQUENCY

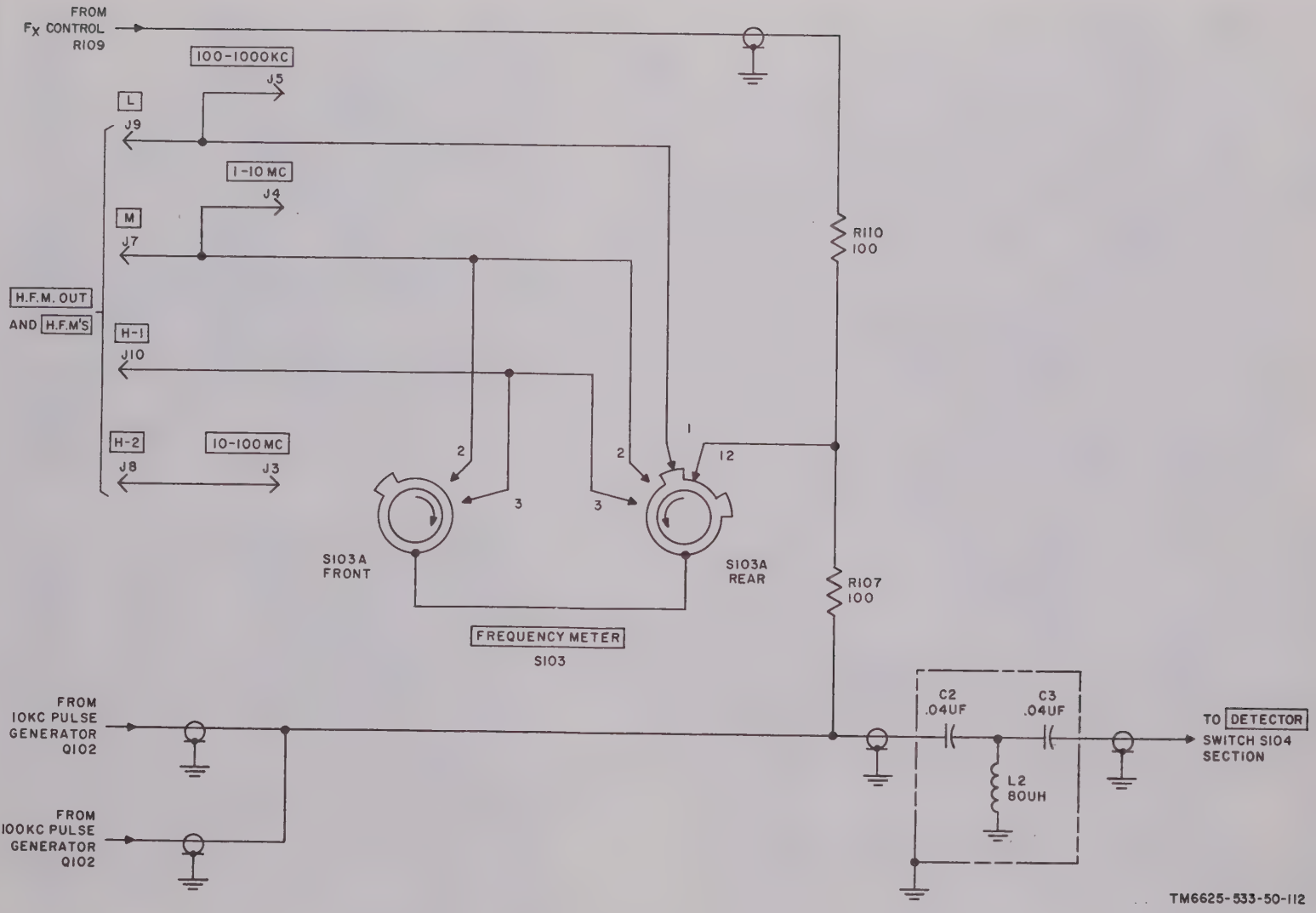


Figure 1–102. FREQUENCY METER switch S103, schematic diagram.

METER switch S301 are applied through DETECTOR switch S104 to the input of the detectors. The output of the detectors is then fed back to DETECTOR switch S104 is applied and coupled to DETECTOR-INTERPOLATOR switch S105.

b. Detailed Operation. The outputs from STANDARD FREQUENCY HARMONICS generator switch (S101) FREQUENCY METER switch (S301), and fx selector switch (S201) are applied to S104, rear section, contact 12, through a high-pass rf filter comprised of C2, C3, and L2. The output of S104, rear section, is as follows:

(1) In the L position, the signal is fed through contact 1 and applied to J26.

(2) In the M position, the signal is fed through contact 2 and applied to J24.

(3) In the H position, the signal is fed through contact 3 and applied to J22.

(4) In the EXT position, the signal is fed through contact 4 and applied to J20.

(5) The outputs of the detectors are applied to J27, J25, J23, and J21. These outputs are then coupled to DETECTOR-INTERPOLATOR SWITCH S105 by contact 6 of S104, front section.

(6) The operation of this section is as follows:

(*a*) In the L position, the output applied to J27 is coupled to S105 through contacts 7 and 6.

(*b*) In the M position, the output applied to J25 is coupled to S105 through contacts 8 and 6.

(*c*) In the H position, the output applied to J23 is coupled to S105 through contacts 9 and 6.

(*d*) In the EXT position, the output applied to J21 is coupled to S105 through contacts 10 and 6.

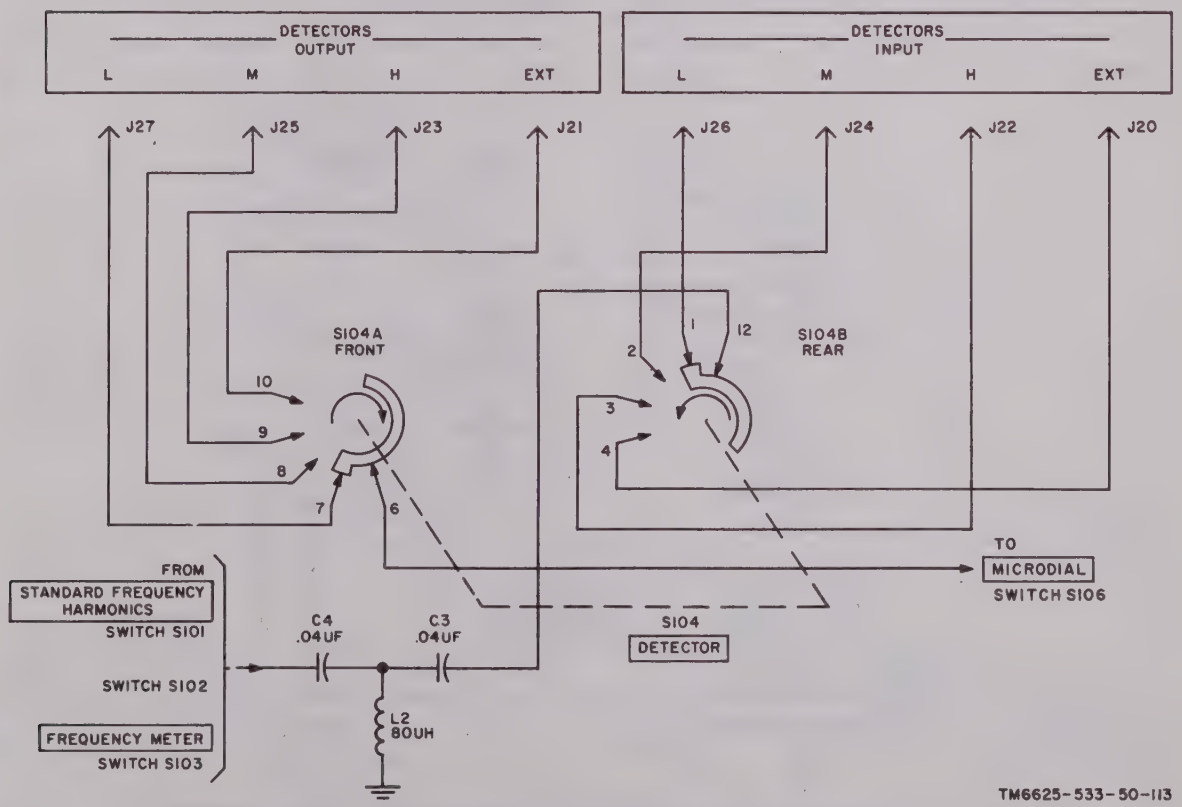


Figure 1–103. DETECTOR switch S104, schematic diagram.

1–102. DETECTOR-INTERPOLATOR Switch S105
(fig. 1–104)

a. General. The output from DETECTOR switch is applied to DETECTOR-INTERPOLATOR switch S105 and to the TEL or SPKR jack.

b. Detailed Operation. Signals selected by DETECTOR switch S104 are applied to S105 through a low-pass filter consisting of C5, C4, C1, and L1. The output of the low-pass filter is continually connected to jacks J14 and J16, and MICRODIAL switch S106. The operation of DETECTOR-INTERPOLATOR switch S105 is as follows:

(1) When S105 is in the DETECTOR SPKR position, signals selected by S104 are connected to J18 through terminals 5 and 4 of the rear section of S105.

(2) When S105 is in the DETECTOR TEL position, the signals selected by S104 are connected to J1 through terminals 5 and 3 of the rear section of S105.

(3) When S105 is in the OFF position, the signals selected by S104 are open circuited and not used.

(4) When S105 is in the INTERPOLATOR TEL position, signals that are applied to J17 or J15 are connected to J1 through terminals 1 and 3, rear section of S105.

(5) When S105 is in the INTERPOLATOR SPKR position, signals that are applied to J17 or J15 are connected to J18 through terminals 1 and 4, rear section of S105.

1–103. MICRODIAL Switch S106
(fig. 1–105)

a. General. Jack J19 can be connected to S105, to ground, or allowed to be open.

b. Detailed Operation. In the SC position J19 is connected to ground through terminals 12 and 1, rear section of S105. In the OFF position, J19 is open. In the ON position, J19 is connected to DETECTOR-INTERPOLATOR switch S105, through terminals 12 and 3, rear section of S106.

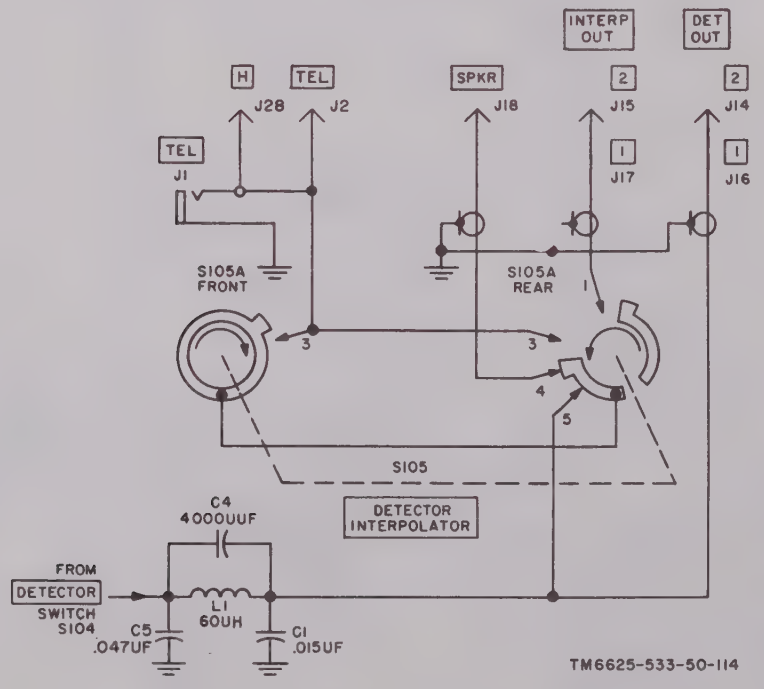


Figure 1–104. DETECTOR-INTERPOLATOR switch S105, schematic diagram.

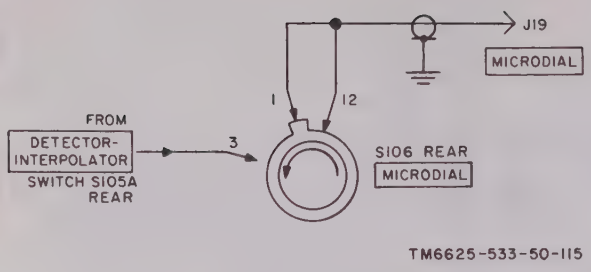


Figure 1–105. MICRODIAL switch S106, schematic diagram.

1–104. Negative Power Supply
(fig. 1–106)

a. General. Primary power of 115 or 230 volts is applied to the primary windings of T501. The ac is rectified, filtered, and a bias voltage is applied to the 10-kc blocking oscillators and the 10-kc and 100-kc pulse generators through S101.

b. Detailed Operation. The 115 or 230 volts ac is applied to the primary of T501 through J501, F501 and F502 fuses, and POWER switch S507. Capacitors C505 and C506 are used as high-frequency bypass capacitors. The secondary is a center-tapped, step-down winding. Diodes CR503 and CR504 are connected to provide full-wave rectification. The combination of C502A, R503 and C502B comprises a pi-type filter network. Resistor R504 is the bleeder resisitor, switch S101 is shown in the OFF position. The first detent clockwise would direct current to 100-kc blocking oscillator Q101 and 100-kc pulse generator Q102. The second detent directs current to 10-kc blocking oscillator Q101 and 10-kc pulse generator Q102. In the third detent, current is directed to both 100-kc and 10-kc blocking oscillators (Q101) and pulse generators (Q102). The fourth detent is an OFF position.

1–105. Positive Power Supply
(fig. 1–107)

a. General. Primary power of 115 or 230 volts is applied to the primary windings of T501. The ac is rectified, filtered, and collector operating voltage is applied to the 100-kc and 10-kc pulse generators.

b. Detailed Operation. The secondary is a center-tapped step-up winding. Diodes CR501 and CR502 are connected to provide full-wave rectification. The combination of C501A, R501, and C501B comprises a pi-type filter network.

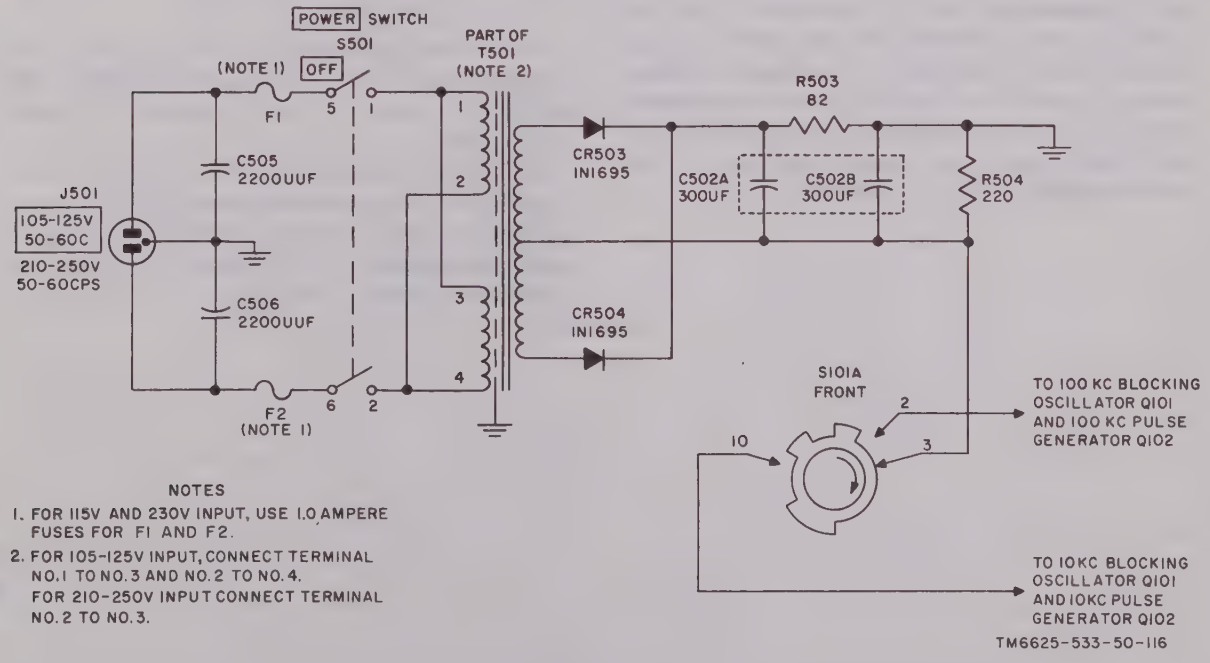


Figure 1–106. Negative power supply, schematic diagram.

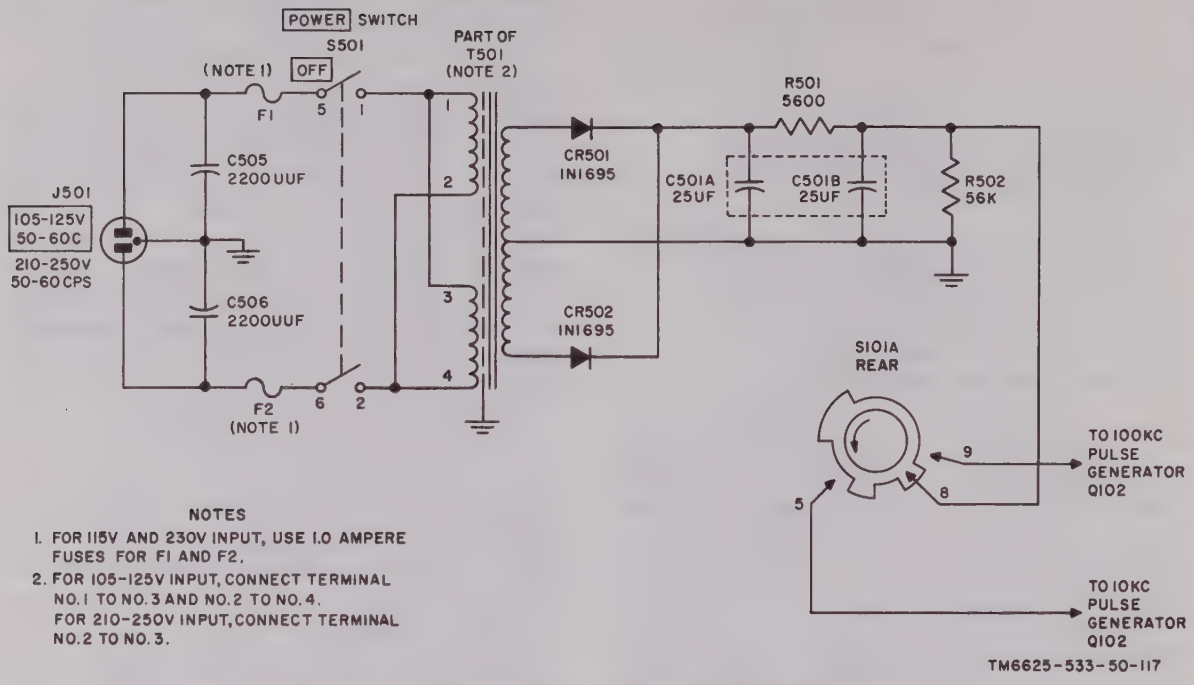


Figure 1–107. Positive power supply, schematic diagram.

Resistor R502 is the bleeder resistor. Switch S101 is shown in the OFF position. The first detent counterclockwise directs current to the 100-kc pulse generator. The second detent directs current to the 10-kc pulse generator. In the third detent, current is directed to both the 100-kc and 10-kc pulse generators. The fourth detent is on OFF position.

1–106. Power Lamp DS501 (fig. 1–108)

a. General. Primary power of 115 or 230 volts is applied to the primary of T501. The secondary voltage of T501 is applied to power lamp DS501.

b. Detailed Operation. The secondary voltage of T501 is connected across DS501 through voltage-dropping resistor R108. When input power is applied, DS501 lights to indicate the presence of power to the unit.

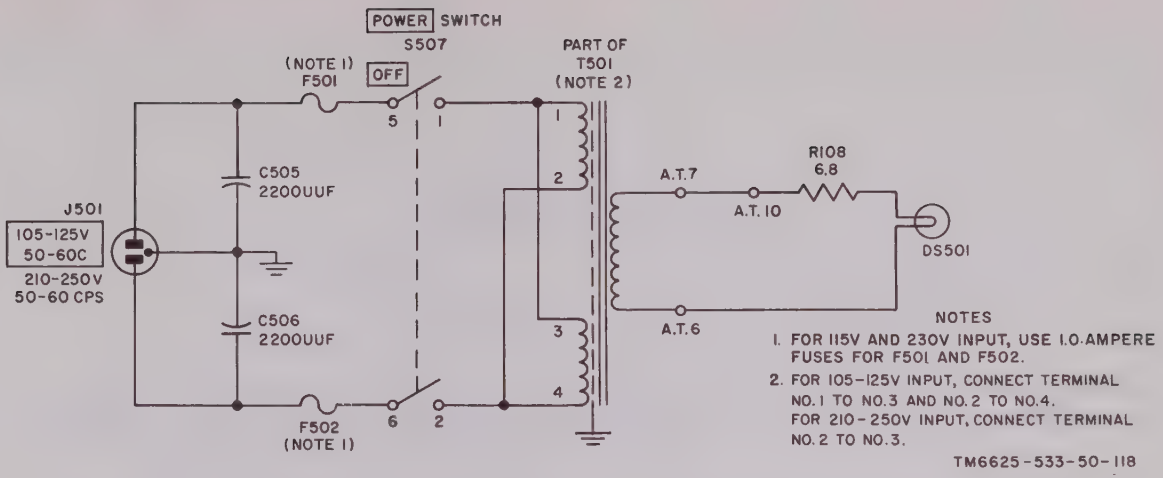


Figure 1–108. Power lamp DS501 circuit, schematic diagram.

CHAPTER 2

TROUBLESHOOTING

Section I. GENERAL TROUBLESHOOTING TECHNIQUES

Warning: **When servicing Calibrator Set, Frequency AN/URM–18A, be extremely careful of high voltages. Always disconnect an individual unit from the powerline before removing or replacing any parts, and short-circuit the high-voltage supplies.**

Caution: **Do not attempt any troubleshooting or repairs of standard frequency oscillator O–1106/URM–18A without having a full understanding of paragraphs 14, 15, and 16, TM 11–6625–345–12.**

2–1. General Instructions

General support and depot level troubleshooting includes all techniques described for organizational maintenance plus any special or additional techniques required to isolate a defective part. The general support and depot maintenance procedures are not complete but are used to supplement the procedures in TM 11–6625–345–12. The systematic troubleshooting which begins with the operational and sectionalization checks that can be performed at organizational level, must be completed by means of sectionalizing, localizing, and isolating techniques.

2–2. Organization of Troubleshooting Procedures

a. General. The first step in servicing a defective calibrator set is to sectionalize the fault; that is, trace the fault to a major unit. The second step is to localize the fault; that is, tracing the fault to a defective part responsible for the abnormal condition. Some faults, such as burned-out resistors and arcing and shorted transformers, can often be located by sight, smell, and hearing. The majority of faults must be located by checking voltages and resistances.

b. Sectionalization. Calibrator Set, Frequency AN/URM–18A consists of 10 units: Standard Frequency Oscillator O–1106/URM–18A; Frequency Multiplier CV–1518/URM–18A; Frequency Divider CV–1517/URM–18A; Frequency Meter FR–43A/URM–18; Frequency Meter FR–44/URM–18; Frequency Meter FR–45A/URM–18; Generator, Signal SG–42/URM–18; Oscilloscope OS–16A/URM–18; Panel Control SB–105A/URM–18; and Loudspeaker, Magnetic LS–205/U. The first step in tracing trouble is to locate the unit or units at fault as follows:

(1) *Visual inspection.* The purpose of visual inspection is to locate faults without testing or measuring circuits. All meter readings or other visual signs should be observed and an attempt made to sectionalize the trouble to a particular unit.

(2) *Operational tests.* Operational tests frequently indicate the general location of trouble. In many instances, the tests will help in determining the exact nature of the trouble. The equipment performance checklists in TM 11–6625–345–12 are good operational tests.

c. Localization. The tests listed below will aid in isolating the trouble. First, localize the trouble to a single stage or circuit, and then isolate the trouble within that circuitry by voltage, resistance, and continuity measurements.

(1) *Signal tracing.* Signal tracing will

help to isolate the trouble to a specific circuit at fault.

(2) *Voltage and resistance measurements.* When measuring voltages, use tape or sleeving to insulate the entire test prod, except for the extreme tip. This equipment contains transistorized circuits. Observe all precautions given to prevent transistor damage. Make voltage and resistance measurements in this equipment only as specified. A momentary short circuit can ruin the transistor. (For example, if the bias is shorted out, excessive current between the emitter and the base would ruin the transistor.) Use resistor and capacitor color codes (fig. 4–1 and 4–2) to find the value of the component. Use voltage and resistance diagrams (fig. 2–58 through 2–66) to find normal readings, and compare them with readings taken.

(3) *Troubleshooting chart.* The trouble symptoms listed in the chart (para 2–17*d*) will aid in localizing trouble to a component part.

(4) *Intermittent troubles.* The possibility of intermittent troubles should not be overlooked. If present, this type of trouble often may be made to appear by gently tapping or jarring the equipment. Check wiring and connections to the units of the calibrator set.

(5) *Signal substitution.* Signal substitution procedures (para 2–18 through 2–27) enables the repairman to localize a trouble quickly to a stage. A signal generator, an audio oscillator, and an oscilloscope are units of test equipment that may be used in signal substitution procedures.

2–3. Test Equipment Required

The following chart lists test equipment required for troubleshooting the calibrator set. Also listed are the asociated technical manuals and the assigned common name.

Test equipment	Technical manual	Common name
Multimeter TS–352/U	TM 11–5527	Multimeter.
Multimeter, Electronic TS–505A/U	TM 11–6625–239–12	Vtvm.
Frequency Meter AN/URM–79	TM 11–5094	Frequency meter.
Generator, Signal AN/URM–25	TM 11–5551	Signal generator.
Radio Receiver R–275/FRR		Radio receiver.
Test Set, Electron Tube TV–7/U	TM 11–6625–274–12	Tube tester.
Oscilloscope AN/USM–140A	TM 11–6625–535–15	Oscilloscope.
Test Set, Transistor TS–1836/U	TM 11–6625–539–15	Transistor tester.

Section II. TROUBLESHOOTING CALIBRATOR SET, FREQUENCY AN/URM–18A

2–4. Sectionalization of Trouble to Individual Unit

In some cases, an individual unit of the calibrator set may not produce desirable results because its output is dependent on the input signal from another individual unit of the calibrator set. To determine which unit is at fault, first read paragraphs 51 and 52 (TM 11–6625–345–12) and follow the sequence of equipment performance check lists in the order they are listed (para 53 through 61, TM 11–6625–345–12).

2–5. Isolating Trouble Within Stage

When trouble has been localized to a stage, either through operational checks or signal substitution (para 2–2), use the following techniques to isolate the defective part:

a. Test the tube involved, by the use of test Set, Electron Tube TV–7/U or by substituting an exact type which is known to be operating normally. Those transistors that are easily removed can be checked on a transistor checker.

b. Take voltage measurements at the tube or transistor sockets. Transistors which are soldered directly into the circuit, voltage measurements are taken at the solder connections and points related to the stage in question.

c. If voltage readings are abnormal, take resistance readings of those stages utilizing tubes only. Refer also to the dc resistances of transformers and coils in paragraph 2–6 through 2–14.

Caution: **Do not make any resistance measurements on those stages of the calibrator set which utilize transistors. Voltages applied by the ohmmeter can destroy the transistor by causing excessive current to flow through the semiconductors.**

d. If signals are weak and all checks fail to indicate a defective part, check the alignment or the adjustment of the stage or unit in question.

e. Use the circuit diagrams (fig. 4–4 through 4–12) to trace circuits and to isolate the faulty component.

2–6. Dc Resistances of Transformers and Coils, Frequency Meter FR–43A/URM–18

The dc resistances of the transformer windings and the coils contained in the low-frequency meter are listed below.

Transformer or coil	Terminals	Ohms
T1 (115-volt wiring)	1-4	9
(230-volt wiring)	1-4	36
	5-6	Less than 1
	7-8	Less than 1
	9-10	210
	10-11	210
L1		0.54
L2		Less than 1
L3		145
L4		40
L8A		22
L8B		5.5
L9A		16.4
L9B		4.2
L10A		10.5
L10B		2.6
L11A		6.3
L11B		1.5
L12A		4.2
L12B		1.1
L13A		3.45
L13B		0.78
L14A		2.4
L14B		0.6
L15A		1.7
L15B		0.47
L16A		1.14
L16B		0.45

2–7. Dc Resistances of Transformers and Coils, Frequency Meter FR–44/URM–18

The dc resistances of the transformer windings and the coils in the medium-frequency meter are listed below.

Transformer or coil	Terminals	Ohms
T1 (115-volt wiring)	1-4	9.14
(230-volt wiring)	1-4	36.6
	5-6	Less than 1
	7-8	Less than 1
	9-10	200
	10-11	215
L1		3.9
L2		2.5
L3		1.9
L4		36
L5		38
L8A		5.37
L8B		2.1
L9A		5.3
L9B		1.89
L10A		3.38
L10B		1.28
L11A		2.7
L11B		1.1
L12A		2.88
L12B		0.86
L13A		1.94
L13B		0.62
L14A		0.84
L14B		0.5
L15A		0.48
L15B		Less than 1
L16A		Less than 1
L16B		Less than 1
L17A		Less than 1
L17B		Less than 1

2–8. Dc Resistances of Transformers and Coils, Frequency Meter FR–45A/URM–18

The dc resistances of the transformer windings and the coils contained in the high-frequency meter are listed below.

Transformer or coil	Terminals	Ohms
T1 (115-volt wiring)	1-4	9
(230-volt wiring)	1-4	36
	5-6	Less than 1
	7-8	Less than 1
	9-10	217
	10-11	2117
L1		Less than 1
L2		Less than 1
L3		Less than 1
L4		Less than 1
L5		Less than 1
L6		Less than 1
L9		Less than 1
L10		Less than 1
L11		Less than 1
L12		Less than 1
L13		Less than 1
L14		Less than 1
L15		Less than 1
L16		Less than 1
L17		Less than 1

2–9. Dc Resistances of Transformers and Coils, Generator, Signal SG–42/URM–18

The dc resistances of the transformer windings and the coils contained in the signal generator are listed below.

Transformer or coil	Terminals	Ohms
T1 (115-volt wiring)	1-4	8.8
(230-volt wiring)	1-4	36.2
	5-6	Less than 1
	7-8	Less than 1
	9-10	189
	10-11	206
L1		14
L2		140
L3		14
L4		140
L5		42

2–10. Dc Resistances of Transformers and Coils, Oscilloscope OS–16A/URM–18

The dc resistances of the transformer windings and coils contained in the oscilloscope are listed below.

Transformer or coil	Terminals	Ohms
T1 (115-volt wiring)	1-4	5.8
(230-volt wiring)	1-4	23.2
	6-7	Less than 1
	8-9	180
	9-10	180
	12-13	Less than 1
	13-14	3,700
	15-16	Less than 1
T2	P-B+	1,630
	G-F−	7,700
T3	P-B+	1,630
	G-F−	700
L1		130
L2		450
L3		140

2–11. Dc Resistances of Transformers and Coils, Frequency Divider CV–1517/URM–18A

The dc resistances of the transformer windings and coils contained in the frequency divider are listed below.

Transformer or coil	Ohms
L101	1.5
L102	6
L103	6
L104	1.3
L105	14.0
L201	5.3
L202	1.5
L203	0.8 red-green
L901	9
L902	1.1
L903	0.6

2–12. Dc Resistances of Transformers and Coils, Standard Frequency Oscillator O–1106/URM–18A

The dc resistances of the transformer windings and coils contained in the frequency calibrator are listed below.

Transformer or coil	Ohms
L201	0.5
L202	0.5
L204	2.25
L205	1.1
L206	1.1
L207	1.1
L601	0.6
T201	1.1
T501	1.1

2–13. Dc Resistances of Transformers and Coils, Frequency Multiplier CV–1518/URM–18A

The dc resistances of the transformer windings and coils contained in the frequency multiplier are listed below.

Transformer or coil	Ohms
L1	Less than 1
L100	10.5
L101	Less than 1
L120	1.7
L140	40
L141	40
L160	5
L201	Less than 1
L200	2.5
L220	Less than 1
L240	40
L241	40
L242	0.6
L260	Less than 1
L261	Less than 1
L300	Less than 1
L301	Less than 1
L320	Less than 1
L340	Less than 1
L341	Less than 1
L342	Less than 1
L343	Less than 1
L344	Less than 1
L345	Less than 1
L360	Less than 1
L361	Less than 1
L362	Less than 1
L363	Less than 1

2–14. Dc Resistances of Transformers and Coils, Panel, Control SB–105A/URM–18

The dc resistances of the transformer windings and coils contained in the control panel are listed below.

Transformer or coil	Ohms
T101, left	0.1
T101, right	0.1
L3	0.25
L1	140

2–15. Checking Filament and B+ Circuits for Shorts

a. When to Check. Check for short circuits before applying power to the units when the following conditions exist:

(1) When the individual units are to be serviced outside of the calibrator set and the nature of the abnormal symptoms is not known.

(2) When abnormal symptoms reported from operational tests indicate possible power supply troubles (equipment performance checklists, paragraphs 53 through 61, TM 11–6625–345–12).

b. Conditions For Tests. Prepare for the short-circuit tests as follows:

(1) Make certain that the unit under test does not have any primary power applied to it.

(2) Remove the unit from the calibrator set.

(3) Remove dust cover from the unit.

(4) Place the on-off switch to the on position.

(5) Remove all tubes.

c. Measurements. Make the resistance measurements indicated in the following chart. If abnormal results are obtained, make the additional isolating checks outlined. When the faulty part is found, repair the trouble before applying power to the unit.

Point of measurements	Normal indication	Isolating procedure
Generator, Signal SG–42/URM-18		
Pin 8 of V8 (fig. 2–49) to ground.	38.5K ohms	If resistance is less than 800 ohms, check C42, C43, or C44 for shorts (fig. 2–49). If the resistance is low check C6, C5, C23 (fig. 2–51), C24, C14, C29A, C29B, C29C and C29D (fig. 2–49).

Dc Resistances of Transformers and Coils, Panel, Control SB–105A/URM–18—*Continued*

Point of measurements	Normal indication	Isolating procedure
Standard Frequency Oscillator O–1106/URM–18A		
Terminal 2 of L1 to ground (fig. 2–16). (Apply the negative lead of the ohmmeter to ground.)	Infinite	If reading is low, check feedthrough capacitors C300, C354, and C370 (fig. 2–18) and C200, C227, C244, and C265 (fig. 2–17), for shorts or leaking conditions. Check filament bypass capacitors C126 and C226 (fig. 2–17), for shorts or leaking conditions. Check CR5 and CR6 (fig. 2–15) for shorts. Check for defective filter capacitor C2A, C2B, C2C (fig. 2–15).
The junction of C1A and R1 and ground (fig. 2–16) (Disconnect P100, P200, and P300 for this measurement. Apply the negative lead of the ohmmeter to ground.)	3.25 megohms	If resistance is less than 150 ohms, check for shorted filter capacitor C1A, C1B, C1C, C1D (fig. 2–15) or check CR1, CR2, CR3, and CR4 (fig. 2–16) for shorts. If the resistance is low, check for shorted C509B, C510, or C511.
Frequency Meter FR–43A/URM–18		
Pin 8 of V4 to ground (fig. 2–34). (For this measurement, place PLATE-OFF switch to on (up) position.)	33.5K ohms	If reading is less than 800 ohms, check for shorted filter capacitor C22, C23, or C24 (fig. 2–33). If the resistance is low, check for shorted resistor in voltage divider network R1, R2, R3 (fig. 2–34). Check for shorted REGENERATION control R27 (fig. 2–33). Check for shorted limiting resistor R28 (fig. 2–34). Check C3 (fig. 2–36) for short or leaking condition. If the resistance is higher than normal, check for an open resistor in one of the resistors listed above or an open R16, R17, R18, or R19 (fig. 2-34).
Frequency Meter FR–44/URM–18		
Pin 8 of V4 to ground (fig. 2–37). (For this measurement, place PLATE-OFF switch to on (up) position.)	31.5K ohms	If reading is less than 800 ohms, check for shorted filter capacitor C22, C23, C24 (fig. 2–33). If the resistance is low, check for shorted resistor in voltage divider network R1, R2, R3, or R4 (fig. 2–37). Check for shorted REGENERATION control R27 (fig. 2–33). Check for shorted limiting resistor R28 (fig. 2–37). Check C3 (fig. 2–39) for short or leaking condition. If the resistance is higher than normal, check for an open resistor in one of the resistors listed above or an open R16, R17, R18 or R19 (fig. 2–37).

Dc Resistances of Transformers and Coils, Panel, Control SB–105A/URM–18—*Continued*

Point of measurements	Normal indication	Isolating procedure
Frequency Meter FR–45A/URM–18		
Pin 8 of V4 to ground (fig. 2–41)	87.7K ohms	If reading is less than 1,000 ohms, check for shorted filter capacitor C22, C23, or C24.
Oscilloscope OS–16A/URM–18		
The junction of C34 and C33 and ground (fig. 2–55).	440K ohms	If resistance is zero, check for a shorted C34 or C33 (fig. 2–53). If the resistance reading is low, check for shorted C32, C31, C5 (fig. 2–53), or C28 (fig. 2–55). If the resistance is higher than normal, check for an open R35 or R34 (fig. 2–55).
Standard Frequency Oscillator O–1106/URM–18A		
The positive lead of the ohmmeter is applied to the junction of CR502, CR504, and the negative lead is applied to ground (fig. 2–7).	25.5K ohms	If the resistance reading is low, check for shorted filter capacitor C501A, C501B, or C501C. Check for shorted C505. Check for shorted C204, C214, C222, C230, or C238.
The positive lead of the ohmmeter is applied to the terminal marked AT58, and the negative lead of the ohmmeter is applied to ground (fig. 2–7).	1,000 ohms	If the resistance reading is low, check for shorted filter capacitor C511A, C511C, C510A, or C510B (fig. 2–53). Check for defective rectifier CR505, CR506 (fig. 2–5) or CR507. Check for shorted capacitor C242, C243, C244, or C245 (fig. 2–9).
Across C512 (fig. 2–5)	1.2K ohms	If the resistance reading is low, check for shorted C512.
Panel Control SB–105A/URM–18		
Positive lead of the ohmmeter applied to the junction of CR502 and CR501 (fig. 2–32) and the negative lead to ground. (Switch S101 (fig. 2–28) in any position.)	61.6K ohms	If the resistance reading is lower, check for shorted capacitor C501A or C501B; shorted resistor R501 or R502; and shorted CR501 or CR502 (fig. 2–32). If the resistance is higher, check for an open R501 or R502.

Dc Resistances of Transformers and Coils, Panel, Control SB–105A/URM–18—*Continued*

Point of measurements	Normal indication	Isolating procedure
Panel Control SB–105A/URM–18 (Continued)		
Negative lead of the ohmmeter applied to junction of C502A and C502B (fig. 2–32), and the positive lead to the junction of R503 and C502A. (Switch S101 (fig. 2–28) in 100/10 kc position.)	200 ohms	If the resistance is zero, check for a shorted C502A. If the resistance is lower, check for shorted C502B, R503, R504 (fig. 2–32), R104 LEFT and RIGHT, and R103 LEFT and RIGHT (fig. 2–31). Also check for shorted CR503 or CR504 (fig. 2–32). If the resistance is higher, check for an open in one of the above resistors.

2–16. Test Setup

Bench tests for the individual units of Calibrator Set, Frequency AN/URM–18A require connection to a line voltage power source of 115 volts, 50 to 60 cycles. Each unit contains its own power supply. The line voltage power source is connected to the units for all dynamic servicing and testing procedures. Test equipment connections vary from test to test. Remove the unit to be serviced from the rack and connect it to a power source. It my also be necessary to provide connections between the remaining units in the rack with those under test.

2–17. Localizing Troubles

a. General. In the troubleshooting charts, procedures are outlined for sectionalizing troubles in each of the individual units and for localizing troubles to a stage within various circuits of these units. Parts locations for all the units of Calibrator Set, Frequency AN/URM–18A are shown in figures 2–1 through 2–56. Voltage and resistance measurements for all the units of calibrator Set, Frequency AN/URM–18A are shown in figures 2–58 through 2–65. Depending on the nature of the operational symptoms, one or more of the localizing procedures will be necessary. When trouble within a unit has been localized to particular stage, use the voltage and resistance measurements to isolate the trouble to a particular part.

b. Use of Chart. The troubleshooting charts are designed to supplement the operational checks in TM 11–6625–345–12. If previous operational checks have resulted in reference to a particular item of these charts, go directly to the referenced item. If no operational symptoms are known, begin with item 1 of the equipment performance checklist (TM 11–6625–345–12) and proceed until a symptom of trouble appears.

Caution: **If operational symptoms are not known, or if they indicate the possibility of short circuits within the power supply of one of the units, make the short-circuit checks described in paragraph 2–5.**

c. Conditions for Test. Perform the operations given in the equipment performance checklist (TM 11–6625–345–12) before using the chart in *d* below, unless trouble has already been localized.

d. Troubleshooting Chart.

(1) *Standard Frequency Oscillator O–1106/URM–18A.*

Item	Symptom	Probable trouble	Correction
1	All indicator lamps (DS201, DS502, and DS501) do not light.	No power applied to frequency calibrator.	Check strapping connections of primary windings on T501 (A, fig. 4, TM 11–6625–345–12).
2	Fuse F501 or F502 blows when replaced.	*a*. Shorted circuit in secondary circuits of T501.	*a*. Make resistance measurements.
		b. Defective T501	*b*. Check resistances of T501 transformer windings.

Troubleshooting Chart—*CONTINUED*

Item	Symptom	Probable trouble	Correction
(1) Standard Frequency Oscillator O–1106/URM–18A (Continued)			
3	Power lamp DS201 does not light.	Defective circuit to power lamp DS201.	Check for open R245, faulty DS201 socket, or open winding between terminals 15 and 16 of T501.
4	OVEN CYCLING-OUTER lamp DS501 does not light.	Defective circuit to lamp DS501	Check for open R607, R608, shorted R534, defective fan B501, defective DS501 socket, open R601, or defective thermostat S601 in the outer oven.
5	OVEN CYCLING-INNER lamp DS502 does not light.	Defective circuit to lamp DS502	Check for defective V505 and the voltage and resistances of its socket (fig. 2–58), a defective DS502 socket, for open winding between terminals 14 and 13 of TS501. Check for open R605, R606, or defective S603 protective thermoswitch in the inner oven.
6	No indication on meter M501 for all positions of METER SWITCH S503.	Defective amplifier filament power supply.	Make frequency calibrator resistance measurements at test point A.T.58. Check the transistor terminal voltages of Q501, Q502, Q503, and Q504 at transistor socket terminals (fig. 2–58). Check all associated components of the above transistors.
		Defective meter M501	Check meter M501 for faulty action.
7	No indication on meter M501 for AGC, OUTPUT, and OSC PLATE positions of METER SWITCH S503.	Defective high-voltage power supply.	Check tubes V501, V502, V503, and V504 and the voltage and resistance at their sockets (fig. 2–58). Check associated components of the above tubes. Check forward and back resistances of diodes CR502, CR501, CR503, and CR504.
8	Incorrect indication on M501 for S503 AGC position and no indication or incorrect M501 indication for S503 OUTPUT and OSC PLATE positions. (Also see item 11.)	Defective oscillator stage	Check tube V201 and the voltages and resistances at its sockets. Check all associated components of V201 including components in inner oven. Check crystal by substitution.
9	No indication or incorrect indication on M501 for S503 AGC and OUTPUT positions.	Defective amplifier or cathode follower stages.	Check tubes V202, V203, and V204A and the voltages and resistances at their sockets. Check all associated components.
10	No indication or incorrect indication on M501 for S503 OUTPUT position.	Defective output amplifier stage	Check tube V204B and the voltages and resistances at its socket. Check all associated components.
11	Incorrect indications on M501 for S503 AGC, OUTPUT, and OSC PLATE positions.	Frequency calibrator misalignment.	Use oscilloscope to view output at J201. If output at J201 is distorted, follow, alignment procedures (para 3–7).

'roubleshooting Chart—*CONTINUED*

(2) *Frequency Multiplier CV–1518/URM–18A.*

tem	Symptom	Probable trouble	Correction
1	With POWER-OFF switch S1 set to POWER, no indication on 1 mc, 10 mc, or 100 mc PHASE DETECTOR meter. (Unit requires 3-hour warmup period.)	*a.* No power applied to 1 mc PHASE DETECTOR meter circuit.	*a.* Check for blown or defective fuse F1 or F2 (fig. 4–5). Replace if defective. Check for proper wiring of terminals on T1 for 115-volt or 230-volt operation.
		b. Short or open circuit within secondary winding of transformer T1 across terminals 8 and 9.	*b.* Make voltage, resistance, and continuity measurements of T1 secondary winding across terminals 8 and 9 (fig. 4–5). Replace if defective.
		c. Defective filament power supply.	*c.* Check forward and back resistance of diodes CR5 and CR6. Take resistance measurement of L1. Check choke input filter network L1, C2A, C2B, and C2C for open or short circuits. Replace if defective. For 1 Mc PHASE DETECTOR meter, check tubes V120, V140A, and 140B. Make voltage and resistance checks at their sockets (fig. 2–59). Check forward and back resistance of diodes CR120 and CR121. Replace if defective. For 10 Mc PHASE DETECTOR meter, check tubes V220, V240A, and V240B. Make voltage and resistance checks at their sockets. Check forward and back resistance of diodes CR220 and CR221. Replace if defective. For 100 Mc PHASE DETECTOR meter, check forward and back resistance of diode CR320. Check tube V340 and perform voltage and resistance measurements of its socket (fig. 2–59). Replace if defective.
		d. Defective regulated B+ power supply.	*d.* Check forward and back resistances of diodes CR1, CR2, CR3, and CR4. Check filter network for open R1, R2, R3, or open or shorted C1A, C1B, C1C, or C1D. Check B+ VR tubes V501, V502, and V503 and the voltage and resistance at their sockets (fig. 2–59). Check all associated components of the above tubes. Replace if defective.
2	Fuse F1 or F2 blows when replaced.	*a.* Short circuit in primary windings of transformer T1.	*a.* Check for proper wiring of terminals on primary windings of T1 for 115- and 230-volt operation. Replace if defective.

Troubleshooting Chart—*CONTINUED*

Item	Symptom	Probable trouble	Correction
		b. Defective transformer T1	*b.* Take voltage and resistance readings of transformer T1 primary windings. Replace if defective.
3	No 1-mc signal at 1-mc OUTPUT jack J101.	*a.* Defective amplifier V160	*a.* Perform signal substitution tests (para 2–20) in the following order: Tubes V160, V140, V120, V101, V100. Replace if defective. Take voltage and resistance measurements at tube socket of V160. Check all associated components of tube V160.
		b. Defective coil L160	*b.* Check for open or short circuit in Coil L160 by making continuity and resistance measurements.
		c. Defective crystal Y100 (1 mc)	*c.* Check crystal Y100. Replace if defective.
4	Weak and distorted output at 1-mc OUTPUT jack J101.	*a.* Defective amplifier V160	*a.* Take voltage and resistance measurements at tube socket of V160. Replace if defective. Check all associated components of tube V160. Replace if defective.
		b. Improper adjustment of C164	*b.* Readjust C164.
		c. Defective stage: V140, V120, V101, or V100 in 1-mc circuit.	*c.* Perform signal substitution tests on the following stages in the order indicated: V140, V120, V101 and V100, (para 2–20). Take voltage and resistance measurements at the tube sockets of V140, V120, V101 and V100 and all associated components. Replace if defective.
5	No 10-mc signal at 10-mc OUTPUT jack J201.	*a.* Defective amplifier V260	*a.* Perform signal substitution tests in the following order on tubes V260, V240, V220, V200. Replace if defective. Take voltage and resistance measurements at tube socket of V260 (fig. 2–59). Check all associated components of tube V260. Replace if defective.
		b. Defective crystal Y200 (10 mc).	*b.* Check crystal Y200. Replace if defective.
		c. Defective coil L261	*c.* Check for open or short circuit in coil L261 by making continuity and resistance measurements. Replace if defective.
		d. Defective coil L260	*d.* Check for open or short circuit in coil L260 by making continuity and resistance measurements. Replace if defective.

Troubleshooting Chart—*CONTINUED*

Item	Symptom	Probable trouble	Correction
		e. No 5-mc output signal from J202 of frequency calibrator to feed J3 of V200 in multiplier.	*e.* Check for open or shorted R219, R229, T201, CR202, CR203, CR204, and V204 if frequency calibrator.
6	Weak and distorted output at 10-mc OUTPUT jack J201.	*a.* Defective amplifier V260	*a.* Take voltage and resistance measurements at tube socket of V260 (fig. 2–59). Replace if necessary. Check all associated components of tube V260. Replace if defective.
		b. Improper adjustment of C263 or C267.	*b.* Readjust C263 and then C267 (para 3–19).
		c. Defective stage: V240, V220 or V200 in 10-mc circuit.	*c.* Perform signal substitution tests on the following stages in the order indicated: V240, V220, and V200 (para 2–20). Take voltage and resistance measurements at the tube sockets of V240, V220, and V200 (fig. 2–59). Replace if defective. Check all associated components of the above tubes. Replace if defective.
7	No 100-mc signal at 100-mc OUTPUT jack J301.	*a.* Defective amplifier V361	*a.* Perform signal substitution tests in the following order on tubes V361, V340, and V300 (para 2–20). Replace if defective. Take voltage and resistance measurements at tube socket of V361 (fig. 2–59). Replace if defective. Check all associated components of V361. Replace if defective.
		b. Defective crystal Y300 (100 mc).	*b.* Check crystal Y300. Replace if defective.
		c. Defective coil L363	*c.* Check for open or short circuit in coil L363 by making continuity and resistance measurements. Replace if defective.
		d. Defective coil L362	*d.* Check for open or short circuit in coil L362 by making continuity and resistance measurements. Replace if defective.
		e. No 5-mc output signal from J202 of frequency calibrator to feed V300 of frequency multiplier.	*e.* Check for open or shorted R219, R229, T201, CR202, CR203, CR204, and V204 in frequency calibrator. Replace if defective.
8	Weak and distorted output at 100-mc OUTPUT jack J301.	*a.* Defective amplifier V361	*a.* Take voltage and resistance measurements at tube socket of V361 (fig. 2–59). Replace if defective. Check all associated components of tube V361. Replace if defective.

Troubleshooting Chart—*CONTINUED*

Item	Symptom	Probable trouble	Correction
		b. Improper adjustment of C369	*b.* Readjust C369.
		c. Defective stage: V340 or V300.	*c.* Perform signal substitution tests for V340 and V300 (para 2–20). Take voltage and resistance measurements at the tube sockets of V340 and V300 (fig. 2–59). Replace if defective. Check all associated components of the above tubes. Replace if defective.
9	No 100-mc signal at 100-mc OUTPUT jack J4.	*a.* Defective amplifier V360	*a.* Perform signal substitution tests for V360, V340, and V300 (para 2–20). Replace if defective. Take voltage and resistance measurements at tube socket of V360 (fig. 2–59). Replace if defective. Check all associated components of V360. Replace if defective.
		b. Defective crystal Y300 (100-mc).	*b.* Check crystal Y300. Replace if defective.
		c. Defective coil L361	*c.* Check for open or short circuit in coil L361 by making continuity and resistance measurements. Replace if defective.
		d. Defective coil L360	*d.* Check for open or short circuit in coil L360 by making continuity and resistance measurements.
		e. No 5-mc output signal from J202 of frequency calibrator to feed V300 of frequency multiplier.	*e.* Check for open or shorted R219, R229, T201, CR202, CR203, CR204, and V204 in frequency calibrator. Replace if defective.
10	Weak and distorted output at 100-mc OUTPUT jack J4.	*a.* Defective amplifier V360	*a.* Take voltage and resistance measurements at tube socket of V360 (fig. 2–59). Replace if defective. Check all associated components of tube V360. Replace if defective.
		b. Improper adjustment of C364	*b.* Readjust C364.
		c. Defective stage: V340 or V300.	*c.* Perform signal substitution tests V340 (para 2–20) and V300. Take voltage and resistance measurements at the tube sockets of V340 and V300 (fig. 2–59). Replace if defective. Check all associated components of the above tubes. Replace if defective.

Troubleshooting Chart—*CONTINUED*

(3) *Frequency Divider CV–1517/URM–18A.*

Item	Symptom	Probable trouble	Correction
1	Fuse F1 or F2 blows when replaced.	*a.* Input voltage is too high	*a.* For 115-volt operation, check for proper wiring of the primary winding of transformer T801 (fig. 4–6). Check the voltage across terminals 2 and 4 of T801.
		b. Shorted plug P801	*b.* Check for defects in wiring of plug P801. Replace if necessary.
2	Indicator lamp DS801 fails to light.	*a.* Open in the secondary winding of transformer T801.	*a.* Check for continuity across the secondary winding of transformer T801. Replace T801 if defective.
3	No output from series regulator Q806.	*a.* Open or shorted diode CR801 or CR802 in the power supply.	*a.* Check forward and back resistance of diodes CR801 and CR802 with an ohmmeter. Replace CR801 or CR802 if defective.
		b. Defective filter capacitor in the power supply.	*b.* Check filter network C803, C804, C805, and C806 for open or short circuits. Replace any filter capacitor found defective.
		c. Defective series regulator Q806.	*c.* Check Q806 with transistor test set. Replace if defective.
		d. Defective stage in power supply regulator circuit.	*d.* Check Q801, Q802, Q803, Q804, and Q805, using transistor tester. Replace if defective. Check all associated components of Q801, Q802, Q803, Q804, Q805.
4	No output from any plug-in unit.	*a.* DRIVING FREQ. switch S801 is defective.	*a.* Check DRIVING FREQ. switch S801 for possible damage. Replace if defective.
		b. DRIVING FREQ. switch S801 set to the wrong position.	*b.* Check that DRIVING FREQ. switch S801 is set to 5 mc.
		c. No 5-mc output signal from J201 of Standard Frequency Oscillator O–1106/URM–18A to act as a driving signal at J102 (5-mc input) of plug-in unit P1 of Frequency Divider CV–1517/URM–18A.	*c.* Perform signal substitution tests on tubes V204B and V204A (para 2–27). Take voltage and resistance measurements at the tube sockets of V204A and V204B. Replace if defective. Check all associated components of the above tubes. Replace if defective.
5	No output from amplifier Q901 of the pulse shaper circuit.	*a.* Contacts 5 and 6 of DRIVING FREQ. switch S801 are shorted out. (S801 is set to 1 mc.)	*a.* Examine contacts 5 and 6 of DRIVING FREQ. switch S801 to see if they are touching each other. Check for possible damage to DRIVING FREQ. switch S801. Replace S801 if defective.

Troubleshooting Chart—*CONTINUED*

Item	Symptom	Probable trouble	Correction
		b. Open contact 5 or 6 of DRIVING FREQ. switch S801. (S801 is set to 1 MC.)	*b.* Check for open contact 5 or 6 of DRIVING FREQ. switch S801. Using a soldering iron, solder the loose wire to the proper contact.
		c. Defective buffer Q104 of plug-in unit P1.	*c.* Check Q104 with transistor tester. Replace if defective.
6	No output from the pulse shaper at test point AT904.	*a.* Defective amplifer Q901 in the pulse shaper circuit.	*a.* Check Q901 with transistor tester. Replace if defective. Check all associated components of Q901. Replace if defective.
		b. Defective monostable multivibrator Q902 and Q903 in the pulse shaper circuit.	*b.* Check Q902 and Q903 with transistor tester. Replace if defective. Check all associated components of Q902 and Q903. Replace if defective.

(4) *Frequency Meter FR–43A/URM–18.*

Item	Symptom	Probable trouble	Correction
1	Frequency meter output low with the voltages on C18 correct for all ranges.	Defective V2 or V3	Check V2 or V3 and replace if defective.
		Defective R9	Check R9 and replace if defective.
		Defective component at V2 or V3	Refer to the voltage and resistance charts (fig. 2–62) concerning V2 or V3 and replace defective components.
2	No frequency meter output and no rf voltage on C18 on any range.	Defective V1 or V4	Check V1 and V4 and replace if defective.
		Defective L3	Check L3 and replace if defective.
		Defective PLATE switch S2	Check S2 and replace if defective.
		Defective components at V1, V4, or V5.	Refer to the voltage and resistance chart (fig. 2–62) concerning V1, V4 or V5 and replace defective components.
		Defective R1, R2, R3, or R19	Check R1, R2, R3, or R19 and replace if defective.
3	No frequency meter output and no rf voltage on C18 on the 100- to 141-kc range.	Defective L1 or frequency meter range switch S1.	Check S1 and replace if defective.
			Check L1 and replace if defective.
4	No frequency meter output and no rf voltage on C18 on the 141- to 282-kc range.	Defective L2 or frequency meter range switch S1.	Check S1 and replace if defective.
			Check L2 and replace if defective.

Troubleshooting Chart—*CONTINUED*

Item	Symptom	Probable trouble	Correction
5	Error in the FREQUENCY METER dial readings on all ranges.	Slippage of the dial on the shaft	If the slippage is caused by a defect within the frequency meter unit replace the complete frequency meter assembly.
6	Error in the FREQUENCY METER dial readings on ranges 100-141 kc, 200, to 282 kc, 400 to 564 kc, 500 to 705 kc and 1,000 to 1,410 kc only.	Defective L1 or the frequency meter range switch S1.	Check S1 and replace if defective. Check L1 and replace if defective.
7	No oscillation of the detector on any range of setting of the REGENERATION control.	Defective R26, R27, R28, C34, or C35. Defective V6 Defective component at V6	Check R26, R27, R28, C34, or C35 and replace defective items. Check V6 and replace if defective. Refer to the voltage and resistance chart concerning (fig. 2–62) and replace defective components.
8	Lack of sensitivity at the DETECTOR OUTPUT with a signal applied to the DETECTOR INPUT jack.	Defective V7 or V8 Defective component at V7 or V8	Check V7 or V8 and replace defective components. Refer to the voltage and resistance chart (Fig. 2–62) concerning V7 and V8 and replace defective components.
9	Error in the DETECTOR dial readings on all ranges.	Defective V6 Defective component at V6	Check V6 and replace if defective. Refer to the voltage and resistance chart (fig. 2–62) concerning V6 and replace defective components.
10	Error in the DETECTOR dial readings on the 100 to 141 range.	Defective L8A or L8B	Check L8A and L8B and replace if defective.
11	Error in the DETECTOR dial readings on the 141 to 200 range.	Defective L9A or L9B	Check L9A and L9B and replace if defective.
12	Error in the DETECTOR dial readings on the 200 to 282 range.	Defective L10A or L10B	Check L10A and L10B and replace if defective.
13	Error in the DETECTOR dial readings on the 282 to 400 range.	Defective L11A or L11B	Check L11A and L11B and replace if defective.
14	Error in the DETECTOR dial readings on the 400 to 564 range.	Defective L12A or L12B	Check L12A and L12B and replace if defective.
15	Error in the DETECTOR dial readings on the 500 to 705 range.	Defective L13A or L13B	Check L13A and L13B and replace if defective.
16	Error in the DETECTOR dial readings on the 705 to 1,000 range.	Defective L14A or L14B	Check L14A and L14B and replace if defective.

Troubleshooting Chart—*CONTINUED*

Item	Symptom	Probable trouble	Correction
17	Error in the DETECTOR dial readings on the 1,000 to 1,410 range.	Defective L15A or L15B	Check L15A and L15B and replace if defective.
18	Error in the DETECTOR dial readings on the 1,410 to 2,000 range.	Defective L16A or L16B	Check L16A and L16B and replace if defective.
19	No detector output on any range.	No signal applied to DETECTOR INPUT jack J2.	Check J2 and the associated shielded wiring for short or open condition.
		Defective V6	Check V6 and replace if defective.
		Defective V7	Check V7 and replace if defective.
		Defective V8A or B	Check V8A and V8B and replace if defective.
		Defective component at V6, V7, V8A, or V8B.	Refer to the voltage and resistance charts (fig. 2–62) concerning V6, V7, V8A, or V8B; replace defective items.
		Defective C28	Check C28 and replace if defective.
		Defective C29	Check C29 and replace if defective.
		Defective C30 or C31	If C30 or C31 is defective, replace the entire detector tuning assembly.
20	No output from the frequency meter and the detector.	Defective V4	Check V4 and replace if defective.
		Defective component at V4	Refer to the voltage and resistance chart (fig. 2–62) concerning V4; replace defective components.
21	No output from the frequency meter.	Defective V2 or V3	Check V2 or V3 and replace if defective.
		Defective component at V2 or V3	Refer to the voltage and resistance chart (fig. 2–62) concerning V2 and V3; replace defective components.

(5) *Frequency Meter FR–44/URM–18.*

Item	Symptom	Probable trouble	Correction
1	No output from the frequency meter at any range.	Defective V1	Check V1 and replace if defective.
		Defective V2	Check V2 and replace if defective.
		Defective V3	Check V3 and replace if defective.
		Defective components at V1, V2, or V3.	Refer to the voltage and resistance chart (fig. 2–63) concerning V1, V2, or V3; replace defective components.
2	Error in the frequency meter dial readings on the 1.00-mc to 1.26-mc, 2.00-mc to 2.52-mc, 4.00-mc to 5.00-mc and 5.00-mc to 6.30-mc ranges.	Defective L1	Check L1 and replace if defective.

Troubleshooting Chart—*CONTINUED*

Item	Symptom	Probable trouble	Correction
3	Error in the frequency meter dial readings on the 1.26-mc to 2.00-mc 3.18-mc to 4.00-mc, and 7.95-mc to 10.00-mc ranges.	Defective L2	Check L2 and replace if defective.
4	Error in the frequency meter dial readings on the 1.59-mc to 2.00-mc 3.18-mc to 4.00-mc, and 7.95-mc to 10.00-mc ranges.	Defective L3	Check L3 and replace if defective.
5	No output from the detector on any range.	Defective V6	Check V6 and replace if defective.
		Defective V7	Check V7 and replace if defective.
		Defective V8A or V8B	Check V8A and V8B and replace if defective.
		Defective component at V6, V7, V8A, or V8B.	Refer to the voltage and resistance chart (fig. 2–63) concerning V6, V7, V8A, or V8B, replace defective items.
		Defective C28	Check C28 and replace if defective.
6	Error in the DETECTOR dial reading on the 1.00-mc to 1.26-mc range.	Defective L8A or L8B	Check L8A and L8B and replace if defective.
7	Error in the DETECTOR dial reading on the 1.26-mc to 1.59-mc range.	Defective L9A or L9B	Check L9A and L9B and replace if defective.
8	Error in the DETECTOR dial reading on the 1.59-mc to 2.00-mc range.	Defective L10A or L10B	Check L10A and L10B and replace if defective.
9	Error in the DETECTOR dial reading on the 2.00-mc to 2.52-mc range.	Defective L11A or L11B	Check L11A and L11B and replace if defective.
10	Error in the DETECTOR dial reading on the 2.52-mc to 3.18-mc range.	Defective L12A or L12B	Check L12A and L12B and replace if defective.
11	Error in the DETECTOR dial reading on the 3.18-mc to 4.00-mc range.	Defective L13A or L13B	Check L13A and L13B and replace if defective.
12	Error in the DETECTOR dial reading on the 4.00-mc to 5.00-mc range.	Defective L14A or L14B	Check L14A and L14B and replace if defective.
13	Error in the DETECTOR dial reading on the 5.00-mc to 6.30-mc range.	Defective L15A or L15B	Check L15A and L15B and replace if defective.
14	Error in the DETECTOR dial reading on the 6.30-mc to 7.95-mc range.	Defective L16A or L16B	Check L16A and L16B and replace if defective.
15	Error in the DETECTOR dial reading on the 7.97-mc to 10.00-mc range.	Defective L17A or L17B	Check L17A and L17B and replace if defective.

Troubleshooting Chart—*CONTINUED*

Item	Symptom	Probable trouble	Correction
16	No oscillation of the detector on any range or setting of the REGENERATION control.	Defective R26, R27, R28, C34, or C35.	Check R26, R27, R28, C34, or C35 and replace if defective.
		Defective V6	Check V6 and replace if defective.
		Defective component at V6	Refer to the voltage and resistance chart (fig. 2–63) concerning V6, replace defective components.
17	Lack of sensitivity of DETECTOR OUTPUT with signal applied to the DETECTOR INPUT.	Defective V7 or V8	Check V7 or V8 and replace if defective.
		Defective component at V7 and V8.	Refer to the voltage and resistance chart (fig. 2–63) concerning V7 and V8, replace defective components.
18	No output from the detector or the frequency meter on any range position.	Defective V4	Check V4 and replace if defective.
		Defective component at V4	Refer to the voltage and resistance chart (fig. 2–63) concerning V4, replace defective components.
		Defective V5	Check V5 and replace if defective.
		Defective component at V5	Refer to the voltage and resistance chart (fig. 2–63) concerning V5, replace defective components.

(6) *Frequency Meter FR–45A/URM–18.*

Item	Symptom	Probable trouble	Correction
1	No output from the frequency meter at any range.	Defective V1	Check V1 and replace if defective.
		Defective V2	Check V2 and replace if defective.
		Defective V3	Check V3 and replace if defective.
		Defective component at V1, V2, or V3.	Refer to the voltage and resistance chart (fig. 2–64) concerning V1, V2, or V3, replace defective components.
2	Error in the frequency meter dial readings on the 10.0-mc to 12.6-mc, 20.0-mc to 25.2-mc, 40.0-mc to 50.0-mc, 50.0-mc to 63.0-mc ranges.	Defective L1	Check L1 and replace if defective.
3	Error in the frequency meter dial readings on the 12.6-mc to 15.9-mc, 25.2-mc to 31.8-mc, and 63.0-mc to 79.5-mc ranges.	Defective L2	Check L2 and replace if defective.
4	Error in the frequency meter dial readings on the 15.9-mc to 20.0-mc, 31.8-mc to 40.0-mc and 79.5-mc to 100-mc ranges.	Defective L3	Check L3 and replace if defective.
5	No output from the detector on any range.	Defective V6	Check V6 and replace if defective.

Troubleshooting Chart—*CONTINUED*

Item	Symptom	Probable trouble	Correction
		Defective V7	Check V7 and replace if defective.
		Defective V8	Check V8 and replace if defective.
		Defective component at V6, V7, or V8.	Refer to the voltage and resistance chart (fig. 2–64) concerning V6, V7, and V8, replace defective components.
6	Error in the DETECTOR dial readings on the 10.0-mc to 12.6-mc range.	Defective L8	Check L8 and replace if defective.
7	Error in the DETECTOR dial reading on the 12.6-mc to 15.9-mc range.	Defective L9	Check L9 and replace if defective.
8	Error in the DETECTOR dial reading on the 15.9-mc to 20.0-mc range.	Defective L10	Check L10 and replace if defective.
9	Error in the DETECTOR dial reading on the 20.0-mc to 25.2-mc range.	Defective L11	Check L11 and replace if defective.
10	Error in the DETECTOR dial reading on the 25.2-mc to 31.8-mc range.	Defective L12	Check L12 and replace if defective.
11	Error in the DETECTOR dial reading on the 31.8-mc to 40.0-mc range.	Defective L13	Check L13 and replace if defective.
12	Error in the DETECTOR dial reading on the 40.0-mc to 50.0-mc range.	Defective L14	Check L14, and replace if defective.
13	Error in the DETECTOR dial reading on the 50.0-mc to 63.0-mc range.	Defective L15	Check L15 and replace if defective.
14	Error in the DETECTOR dial reading on the 63.0-mc to 79.5-mc range.	Defective L16	Check L16 and replace if defective.
15	Error in the DETECTOR dial reading on the 79.5-mc to 100.0-mc range.	Defective L17	Check L17 and replace if defective.
16	No oscillation of the detector on any range of the range switch or setting of the REGENERATION control.	Defective R27 and R29	Check R27 or R29 and replace if defective.
		Defective V6	Check V6 and replace if defective.
		Defective component at V6	Refer to the voltage and resistance chart (fig. 2–64) concerning V6, replace defective components.
17	Lack of sensitivity at the DETECTOR OUTPUT with signal applied to the DETECTOR INPUT.	Defective V7	Check V7 and replace if defective.
		Defective V8	Check V8 and replace if defective.
		Defective component at V8 or V7	Refer to the voltage and resistance chart (fig. 2–64) concerning V7 or V8, replace defective components.

Item	Symptom	Probable trouble	Correction
18	No output from the frequency meter or the detector on any range.	Defective V4	Check V4 and replace if defective.
		Defective V5	Check V5 and replace if defective.
		Defective power supply rectifier CR1.	Check CR1 and replace if defective.
		Defective component at V4 or V5.	Refer to the voltage and resistance chart (fig. 2–64) concerning V4 or V5, replace defective components.

(7) *Generator, Signal SG–42/URM–18.*

Item	Symptom	Probable trouble	Correction
1	No output from the 42- or 47-kc fixed oscillator.	Defective V1	Check V1 and replace if defective.
		Defective component at V1	Refer to the voltage and resistance chart (fig. 2–65) concerning V1; replace defective components.
		Defective V2	Check V2 and replace if defective.
		Defective component at V2	Refer to the voltage and resistance chart (fig. 2–65) concerning V2; replace defective components.
		Defective L1	Check L1 and replace if defective.
		Defective C4	Check C4 and replace if defective.
2	No output from the 42- to 47-kc variable oscillator.	Defective V2	Check V2 and replace if defective.
		Defective component at V2	Refer to the voltage and resistance chart (fig. 2–65) concerning V2; replace defective components.
		Defective V3	Check V3 and replace if defective.
		Defective component at V3	Refer to the voltage and resistance chart (fig. 2–65) concerning V3; replace defective components.
		Defective L3 or L4	Check L3 and L4 and replace defective components.
3	No output at J2 with no input at J3.	Defective V5A	Check V5 and replace if defective.
		Defective component at V5A	Refer to the voltage and resistance chart (fig. 2–65) concerning V5A; replace defective components.
		Defective RF filter	Check L5, C27, C26 and C28. Replace defective components.
		Defective V6A	Check V6 and replace if defective.
		Defective component at V6A	Refer to the voltage and resistance chart (fig. 2–65) concerning V6A; replace defective components.
		Defective V5B	Check V5 and replace if defective.
		Defective component at V5B	Refer to the voltage and resistance chart (fig. 2–65) concerning V5B; replace defective components.
		Defective V6B	Check V6 and replace if defective.

Troubleshooting Chart—*CONTINUED*

Item	Symptom	Probable trouble	Correction
		Defective component at V6B	Refer to the voltage and resistance chart (fig. 2–65) concerning V6; replace defective components.
4	No output detected at J2 when a signal is applied to input jack J3.	Defective V7	Check V7 and replace if defective.
		Defective component at V7	Refer to the voltage and resistance chart (fig. 2–65) concerning V7; replace defective components.
5	Low output and low rf voltage at L2.	Defective V1	Check V1 and replace if defective.
		Aging of fixed oscillator components.	Refer to the alinement and adjustment procedure (para 3–22) concerning the adjustment of R3; perform the necessary correction.
6	Low output and low rf voltage at L4.	Defective V4	Check V4 and replace if defective.
		Aging of the variable oscillator components.	Refer to the alinement and adjustment procedure (para 3–22) concerning R15; perform the necessary corrections.
7	Low output and all rf and audio voltages low.	Defective V8	Check V8 and replace if defective.
		Defective V9	Check V9 and replace if defective.
		Defective component at V8	Refer to the voltage and resistance chart (fig. 2–65) concerning V8; replace defective components.
		Defective component at V9	Refer to the voltage and resistance chart (fig. 2–65) concerning V9; replace defective components.
8	Low output in the DIRECT position of the REVERSE-DIRECT switch.	V1 aging	Readjust R5 for the correct output voltage.
		Defective V1	Check V1 and replace if defective.
9	Low output in the REVERSE position of the REVERSE-DIRECT switch.	V1 aging	Readjust R8 for the correct output voltage.
			Check V1 and replace if defective.

(8) *Oscilloscope OS–16A/URM–18.*

Item	Symptom	Probable trouble	Correction
1	No spot or trace on the screen.	Defective V6	Check V6 and replace if defective.
		Defective component at V6	Refer to the voltage and resistance chart (fig. 2–66) concerning V6; replace defective components.
		Defective V5	Check V5 and replace if defective.
		Defective component at V5	Refer to the voltage and resistance chart (fig. 2–66) concerning V6; replace defective component.
2	Spot or trace on screen weak and faded.	Defective V6	Check V6 and replace if defective.
		Defective V5	Check V5 and replace if defective.

Troubleshooting Chart—*CONTINUED*

Item	Symptom	Probable trouble	Correction
		Defective component at V5 or V6	Refer to the voltage and resistance chart (fig. 2–66) concerning V5 and V6; replace defective components.
3	Spot or trace cannot be centered on the screen.	Defective V6	Check V6 and replace if defective.
		Defective component at V6	Refer to the voltage and resistance chart (fig. 2–66) concerning V6; replace defective components.
		Defective R26 or R25	Check R25 or R26 and replace if defective.
		Defective C30	Check C30 and replace if defective.
4	No circle with the CIRCULAR SWEEP FREQUENCY switch at LINE, and the SELECTOR switch at X-STD CIC SW.	Defective V1	Check V1 and replace if defective.
		Defective component at V1	Refer to the voltage and resistance chart (fig. 2–66) concerning V1; replace defective components.
		Defective R2	Check R2 and replace if defective.
		Defective V2	Check V2 and replace if defective.
		Defective component at V2	Refer to the voltage and resistance chart (fig. 2–66) concerning V2; replace defective components.
		Defective V3	Check V3 and replace if defective.
		Defective component at V3	Refer to the voltage and resistance chart (fig. 2–66) concerning V3; replace defective components.
		Defective C1 or C6	Check C1 or C6 and replace if defective.
		Defective L1	Check L1 and replace if defective.
5	No circle with the CIRCULAR SWEEP FREQUENCY switch in the 100 cycle position and the SELECTOR switch at X-STD CIRC SW.	No signal at 100-cycle jack J4	Check J4 and the shielded lead for shorted or open conditions.
		Defective C1 or C7	Check C1 or C7 and replace if defective.
		Defective R2	Check R2 and replace if defective.
		Defective V2	Check V2 and replace if defective.
		Defective component at V2	Refer to the voltage and resistance chart (fig. 2–66) concerning V2; replace defective components.
		Defective V3	Check V3 and replace if defective.
		Defective component at V3	Refer to the voltage and resistance chart (fig. 2–66) concerning V3; replace defective components.
		Defective L1	Check L1 and replace if defective.
6	No circle with the CIRCULAR SWEEP FREQUENCY switch in the 1-kc position and the SELECTOR at X-STD CIRC SW.	No signal applied to 1-kc jack J3	Check J3 and the shielded lead for shorts.
		Defective V1	Check V1 and replace if defective.

Troubleshooting Chart—*CONTINUED*

Item	Symptom	Probable trouble	Correction
		Defective component at V1	Refer to the voltage and resistance chart (fig. 2–66) concerning V1; replace defective components.
		Defective R2	Check R2 and replace if defective.
		Defective V2	Check V2 and replace if defective.
		Defective component at V2	Refer to the voltage and resistance chart (fig. 2–66) concerning V2 and replace defective components.
		Defective V3	Check V3 and replace if defective.
		Defective component at V3	Refer to the voltage and resistance chart (fig. 2–66) concerning V3 and replace defective components.
		Defective L2	Check L2 and replace if defective.
7	No circle with the CIRCULAR SWEEP FREQUENCY switch in the 10-kc position and the SELECTOR switch at X-STD CIRC SW.	No signal applied to 10-kc jack J2	Check J2 and the shielded lead for open or shorted conditions.
		Defective V1	Check V1 and replace if defective.
		Defective R2	Check R2 and replace if defective.
		Defective V2	Check V2 and replace if defective.
		Defective component at V2	Refer to the voltage and resistance chart (fig. 2–66) and replace components found defective.
		Defective V3	Check V3 and replace if defective.
		Defective component at V3	Refer to the voltage and resistance chart (fig. 2–66) concerning V3; replace defective components.
		Defective L3	Check L3 and replace if defective.
		Defective component at V1	Refer to the voltage and resistance chart (fig. 2–66) concerning V1; replace if defective.
8	No circle with the CIRCULAR SWEEP FREQUENCY switch at INTERP OSC, and the SELECTOR at X-STD CIRC SW.	No signal to INTERP OUT jack J5 at frequencies of 2,500 to 5,000 cycles per second.	Check J5 and the shielded lead for open or shorted conditions.
		Defective V2	Check V2 and replace if defective.
		Defective component at V2	Refer to the voltage and resistance chart (fig. 2–66) concerning V2; replace defective components.
		Defective V3	Check V3 and replace if defective.
		Defective component at V3	Refer to the voltage and resistance chart (fig. 2–66) concerning V3; replace defective components.
		Defective R10	Check R10 and replace if defective.
9	Horizontal line only with the CIRCULAR SWEEP FREQUENCY switch at LINE and the SELECTOR switch at X-STD CIRC SW.	Defective R11	Check R11 and replace if defective.
		Defective V3	Check V3 and replace if defective.
		Defective component at V3	Refer to the voltage and resistance chart (fig. 2–66) concerning V3; replace defective components.
		Defective T2	Check T2 and replace if defective.

Troubleshooting Chart—*CONTINUED*

Item	Symptom	Probable trouble	Correction
10	Vertical line only with the CIRCULAR SWEEP FREQUENCY switch at LINE and the SELECTOR at X-STD CIRC SW.	Defective C12	Check C12 and replace if defective.
		Defective V3	Check V3 and replace if defective.
		Defective component at V3	Refer to the voltage and resistance chart (fig. 2–66) concerning V3; replace defective components.
		Defective T3	Check T3 and replace if defective.
11	Elliptical trace with the CIRCULAR SWEEP FREQUENCY switch at LINE and the SELECTOR switch at X-STD CIRC SW.	Defective C17	Check C17 and replace if defective.
		R9 maladjusted	Refer to the adjustment procedure concerning R9 (para 3–28).
12	No vertical line with the SELECTOR switch at DET INTERP.	No signal applied to DET OUT jack J6.	Check J6 and the shielded lead for shorts or open conditions.
		Defective V3	Check V3 and replace if defective.
		Defective component at V3	Refer to the voltage and resistance chart (fig. 2–66) concerning V3; replace defective components.
		Defective T2	Check T2 and replace if defective.
13	No horizontal line with the SELECTOR switch at DET INTERP.	No signal applied to INTERP OUT jack J5.	Check J5 and the shielded lead for shorted or open conditions.
		Defective V3	Check V3 and replace if defective.
		Defective component at V3	Refer to the voltage and resistance chart (fig. 2–66) concerning V3; replace defective components.
		Defective T3	Check T3 and replace if defective.
14	Horizontal line only with the CIRCULAR SWEEP FREQUENCY switch at INTERP OSC and the SELECTOR switch at X-STD CIRC SW.	Defective V2	Check V2 and replace if defective.
		Defective component at V2	Refer to the voltage and resistance chart (fig. 2–66) concerning V2; replace defective components.
		Defective V3	Check V3 and replace if defective.
		Defective component at V3	Refer to the voltage and resistance chart (fig. 2–66) concerning V3; replace defective components.
		Defective T3	Check T3 and replace if defective.
15	Vertical line only with the CIRCULAR SWEEP FREQUENCY switch at INTERP OSC and the SELECTOR switch at X-STD CIRC SW.	Defective V2	Check V2 and replace if defective.
		Defective component at V2	Refer to the voltage and resistance chart (fig. 2–66) concerning V2; replace defective components.
		Defective V3	Check V3 and replace if defective.
		Defective component at V3	Refer to the voltage and resistance chart (fig. 2–66) concerning V3; and replace defective components.
		Defective T3	Check T3 and replace if defective.

Troubleshooting Chart—*CONTINUED*

Item	Symptom	Probable trouble	Correction
16	Smooth circle but no loops with the CIRCULAR SWEEP FREQUENCY switch at LINE and the SELECTOR switch at X-STD CIRC SW.	No signal applied to X jack J1	Check J1 and the shielded lead for shorts or open conditions.
		Defective V4	Check V4 and replace if defective.
		Defective component at V4	Refer to the voltage and resistance chart (fig. 2–66) concerning V4; replace defective components.
		No signal applied to V5	Inspect V5 cap for proper connection.
17	Dc voltages low on V1, V2, V3, and V4.	Defective V7	Check V7 and replace if defective.
		Defective component at V7	Refer to the voltage and resistance chart (fig. 2–66) concerning V7; replace defective components.

(9) *Panel, Control SB–105A/URM–18.*

Item	Symptom	Probable trouble	Correction
1	No output from the 10-kc harmonic generator with the harmonic selector switch in the 10-kc and 100/10-kc positions.	Defective A2Q101	Check A2Q101 and replace if defective.
		Defective A2Q102	Check A2Q102 and replace if defective
		No signal input at J12	Check J12 and the shielded lead for short or open circuit condition.
		Defective component in the A2Q101 or A2Q102 circuit.	Refer to the voltage chart (fig. 2–61) concerning A2Q101 and A2Q102; replace defective components.
2	No output from the 100-kc harmonic generator with the harmonic generator selector switch in the 100-kc and 100/10-kc positions.	Defective A1Q101	Check A1Q101 and replace if defective.
		Defective A1Q102	Check A1Q102 and replace if defective.
		No signal input at J11	Check J11 and the shielded lead connected to it for short or open circuit condition.
		Defective component in the A1Q101 or A1Q102 circuit.	Refer to the voltage chart (fig. 2–61) concerning A1Q101 or A1Q102; replace defective components.
3	No output from the 100-kc and the 10-kc harmonic generators on any position of the harmonic generator selector switch.	Defective positive power supply rectifier or an associated component.	Check CR501 and CR502; replace defective components.
			Perform resistance and voltage checks on the power supply filter network and replace defective components.
		Defective negative power supply rectifier or an associated component.	Check CR503 and CR504; replace defective components.

Troubleshooting Chart—*CONTINUED*

Item	Symptom	Probable trouble	Correction
			Perform resistance and voltage checks on the power supply filter network and replace defective components.
		Defective harmonic selector switch.	Check S101 and replace if defective.

(10) *Loudspeaker, Magnetic LS–205/U.*

Item	Symptom	Probable trouble	Correction
1	No audio output from the loudspeaker.	Defective speaker	Check speaker and replace if defective.
		Defective audio transformer T1	Check T1 and replace if defective.
		Defective J1	Check J1 and the associated wiring; replace if defective.
2	Distorted audio output	Defective speaker	Check speaker and replace if defective.

Section III. SIGNAL SUBSTITUTION

2–18. Signal Substitution, General Instructions

Signal substitution procedures can be used to localize troubles to a stage in each of the units. In some cases, externally generated signal will be substituted for the signal normally present in the various stages of the individual units, in other cases, a signal from another calibrator set unit will be used. In all cases in the following tests, one side of the signal input source and the indicating equipment will be grounded and the other side will be connected to the test points indicated. For each unit, perform all tests below in sequence. Paragraphs 2–19 through 2–27 contain signal substitution charts for each unit. These charts contain the following information:

Signal frequency — The frequency of the input signal.

Connections — The points to which the signal source and indicating equipment is to be connected.

Switch and control settings — The position of switches or controls if they are involved with final results.

Normal indication — The results indicated if the circuit or circuits are functioning normally.

Possible trouble — If the results are not as indicated, a component or group of components is given which might be causing the abnormality.

2–19. Signal Substitution, Control Panel

a. S105, S106, S104 Front, Associated Circuitry and Jacks.

(1) *Test conditions.*

(*a*) All cables disconnected at rear panel, including cable W1 (fig. 22, TM 11–6625–345–12).

(*b*) Connect external signal generator output to J19 MICRODIAL jack.

(*c*) Adjust input signal amplitude for a comfortable listening level.

(2) *Signal substitution chart.*

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
1 kc	Connect headphones to J14, DET OUT 2.	*a.* Position MICRODIAL switch to OFF.	*a.* No audible 1-kc note.	*a.* Defective S106.
		b. Position MICRODIAL switch to ON.	*b.* Hear 1-kc note.	*b.* Defective S106.
1 kc	Connect headphones to J27.	Position MICRODIAL switch to ON and the DETECTOR switch to L, M, H and EXT in turn.	Hear 1 kc note on DETECTOR switch position L only.	Defective S106, S104, L1, C1, C5, or J27.
1 kc	Connect headphones to J25, DETECTORS OUTPUT M.	Position MICRODIAL switch to ON and the DETECTOR switch to M, H, and EXT in turn.	Hear 1-kc note on DETECTOR switch position M only.	Defective S106, S104, L1, C1 or C5 or J25.
1 kc	Connect headphones to J23, DETECTORS OUTPUT H.	Position MICRODIAL switch to ON and the DETECTOR switch to H and EXT in turn.	Hear 1-kc note on DETECTOR switch position H only.	Defective S104, S106, L1, C1, C5 or J23.
1 kc	Connect headphones to J21, DETECTORS OUTPUT EXT.	Position MICRODIAL switch to ON and the DETECTOR switch to EXT.	Hear 1-kc note _____	Defective S104, S106, L1, C1, C5, or J21.
1 kc	Connect headphones to J18, SPKR.	Position MICRODIAL switch to ON and the DETECTOR-INTERPOLATOR switch fully counterclockwise.	Hear 1-kc note _____	Defective S106, S105 or J18.
1 kc	Connect J14 DET OUT to J15, INTERP OUT. Connect headphones to J18, SPKR.	Position MICRODIAL switch to ON and the DETECTOR-INTERPOLATOR switch fully clockwise.	Hear 1-kc note _____	Defective S106 or S105, J14, J15, or J18.
1 kc	Connect J14, DET OUT, to J15, INTERP OUT, Connect headphones to J18 SPKR.	Position MICRODIAL switch to ON and the DETECTOR-INTERPOLATOR switch to TEL, OFF, and TEL.	No audible 1-kc note heard in any position.	Defective S105.
1 kc	Connect J14, DET OUT, to J15, INTERP OUT. Connect headphones to J17, INTERP OUT.	Position MICRODIAL switch to ON.	Hear 1-kc note _____	Defective S106, J14, J15 or J17.
1 kc	Connect J14, DET OUT, to J15, INTERP OUT. Connect headphones to J2, TEL.	*a.* Position MICRODIAL switch to ON and the DETECTOR-INTERPOLATOR switch to DETECTOR TEL.	*a.* Hear 1-kc note _____	*a.* Defective S105, S106 or J2.
		b. Position MICRODIAL switch to ON and the DETECTOR-INTERPOLATOR switch to INTERPOLATOR TEL.	*b.* Hear 1-kc note _____	*b.* Defective S105, S106, J14, J15 or J2.

(2) Signal substitution chart—*CONTINUED*

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
		c. Position MICRODIAL switch to ON and the DETECTOR-INTERPOLATOR switch SPKR, OFF, and SPKR.	*c.* No audible 1-kc note heard in any position.	*c.* Defective S105

b. S103, S104 Rear, Associated Circuitry and Jacks.

(1) *Test conditions.*

(*a*) All cables disconnected at rear panel of control panel, including cable W1 (fig. 22, TM 11–6625–345–12).

(*b*) Connect external signal generator output to J13 fx-2 jack.

(*c*) Position fx selector fully clockwise (fx 1 & 2).

(*d*) Position STANDARD FREQUENCY HARMONICS-10 kc and 100 kc controls fully counterclockwise.

(2) *Signal substitution chart.*

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
3.5-kc square wave	Connect headphones to J5, 100-1,000-kc jack.	*a.* Position FREQUENCY-METER switch to L and then to L-H.	*a.* Hear 3.5-kc signal in both positions.	*a.* Defective S102, R109, R110, S103, J13 or J5.
		b. Position FREQUENCY-METER switch to M, H and M-H in turn.	*b.* No audible 3.5-kc signal heard in any position.	*b.* Defective S103.
3.5-kc square wave	Connect headphones to J4 1-10-mc jack.	*a.* Position FREQUENCY-METER switch to M and M-H.	*a.* Hear 3.5-kc signal in all positions.	*a.* Defective S102, R109, R110, S103, J13, or J4.
		b. Position FREQUENCY-METER switch to L and H.	*b.* No audible 3.5-kc signal heard in any position.	*b.* Defective S103.
3.5-kc square wave	Connect headphones to J10, H-1 jack.	*a.* Position FREQUENCY-METER switch to H and M-H.	*a.* Hear 3.5-kc signal in both positions.	*a.* Defective S102, R109, R110, S103, or J10.
		b. Position FREQUENCY-METER switch to L, M, and L-M.	*b.* No audible 3.5-kc signal heard in any position.	*b.* Defective S103.
3.5-kc square wave	Connect headphones to J26 DETECTORS INPUT-L.	*a.* Position DETECTOR switch to L.	*a.* Hear 3.5-kc signal faintly.	*a.* Defective S102, R109, R110, R107, C2, L2, C3, S104, J13, or J26.
		b. Position DETECTOR switch to M, H, and EXT in turn.	*b.* No audible 3.5-kc signal heard in any position.	*b.* Defective S104.
3.5-kc square wave	Connect headphones to J24 DETECTORS INPUT-M.	*a.* Position DETECTOR switch to M.	*a.* Hear 3.5-kc signal faintly.	*a.* Defective S102, R109, R110, R107, C2, L2, C3, S104, J13, or J24.

(2) Signal substitution chart (Continued)

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
		b. Position DETECTOR switch to L, H, and EXT.	*b.* No audible 3.5-kc signal heard in any position.	*b.* Defective S104.
3.5-kc square wave	Connect headphones to J22 DETECTORS INPUT-H.	*a.* Position DETECTOR switch to H.	*a.* Hear 3.5-kc signal faintly.	*a.* Defective S102, R109, R110, R107, C2, L2, C3, S104, J13, or J22.
		b. Position DETECTOR switch to L, M, EXT.	*b.* No audible 3.5-kc signal heard in any position.	*b.* Defective S104.
3.5-kc square wave	Connect headphones to J20 DETECTORS INPUT-EXT.	*a.* Position DETECTOR switch to EXT.	*a.* Hear 3.5-kc signal faintly.	*a.* Defective S102, R109, R110, R107, C2, L2, C3, S104, J13, or J20.
		b. Position DETECTOR switch to L, M, and H.	*b.* No audible 3.5-kc signal is heard in any position.	*b.* Defective S104.

c. S102, Associated Circuitry and Jacks.

(1) *Test conditions.*

(*a*) All cables disconnected at rear panel of control panel, including W1 (fig. 22, TM 11–6625–345–12).

(*b*) Position STANDARDS FREQUENCY HARMONICS-10 kc and 100 kc controls fully counterclockwise.

(*c*) Position FREQUENCY METER switch to H.

(*d*) Connect external signal generator to J10 H-1 jack.

(2) *Signal substitution chart.*

Note. In the following checks, the signal input is connected to J10, H-1. The FREQUENCY METER switch is positioned to H.

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
1 kc	Connect headphones to J13 check fx-2 jack	Position fx selector to fx-2 and fx-1&2 in turn.	Hear 1-kc note in both positions to see that the fx control varies the audio level.	Defective S103, S102, R109, R107, J13, or J10.
1 kc	Connect headphones to J13, fx-2 jack.	Position fx selector to GND and fx-1 in turn. Fx control fully clockwise.	No audible 1-kc note is heard in either position.	Defective S102.
1 kc	Connect headphones to J6, fx-1 jack.	Position fx selector to fx-1 and fx-1&2 in turn.	Hear 1-kc note in both positions. Check that fx control varies the audio level.	Defective S103, S102, R109, R107, J6, J10.
1 kc	Connect headphones to J6, fx-1 jack.	Position fx selector to GND and fx-2 in turn. Fx control fully clockwise.	No audible 1-kc note is heard in either position.	Defective S102.

d. Low- and High-Pass Filters.

(1) *Conditions.*

(*a*) All cables disconnected to rear panel of control panel, including W1 (fig. 22, TM 11–6625–345–12).

(*b*) Position STANDARD FREQUENCY HARMONIC-10 kc and 100 kc controls fully counterclockwise.

(2) *Signal substitution chart.*

Note. To check the operation of the high-pass and low-pass filters, perform the operations as directed in following chart.

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
		LOW-PASS FILTER		
5 kc at 2 volts.	Connect external signal generator to J27 DETECTORS OUTPUT-L jack. Connect an ac voltmeter to J16 DET OUT-1 jack.	DETECTOR switch to L position.	Adjust the signal generator frequency minimum indication on the ac voltmeter. This should occur between 4.5 and 5.5KC. Readjust the output level of the signal generator for 2 volts indication. Check the output voltage of the generator. This should be between 15 and 17 volts ac.	Defective lowpass filter L1, C5, or C1 or defective S104, J21 or J16.
		HIGH-PASS FILTER		
10 kc at 7 volts.	Connect external signal generator to J5 HFM OUT 100-1,000-kc jack. Connect an ac voltmeter to J26 DETECTORS INPUT-L jack.	DETECTOR switch to L, FREQUENCY METER switch to L, fx selector to fx-1 and position the fx control fully clockwise.	Less than 0.1-volt indication on the voltmeter.	Defective high-pass filter C2, C3 or L2 or Defective R107, R110, R109, S103, S104, J26 or J5.
10 kc at 7 volts.	J5 HFM OUT 100-1,000-kc jack. Connect an ac voltmeter to J26 DETECTORS INPUT-L jack.	FREQUENCY METER switch set to L. Throw fx switch to fx-1. Position the fx control fully clockwise.	More than 0.8-volt indication on the voltmeter.	Defective high-pass filter, C2, C3 and L2. Defective R107, R110, S103 or S104.

e. Harmonic Generators.

(1) *Condition.*

(*a*) Connect cable W109 to control panel J12 and cable W108 to control panel J11 (fig. 22, TM 11–6625–345–12).

(*b*) Using the frequency divider 1-kc output, synchronize the sweep of the oscilloscope at a sweep speed of 20 usec/cm and adjust the vertical deflection for 2 volts/cm.

(*c*) Connect ocilloscope to the junction of the control panel 10-kc and 100-kc generator output.

(*d*) Turn control panel POWER-OFF switch to on position. (Frequency calibrator and frequency divider should be energized.)

(2) *Signal substitution chart.*

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
Standard 100-kc square wave.		STANDARD FREQUENCY HARMONICS selector to 100-kc. The STANDARD FREQUENCY HARMONICS 100-kc control maximum clockwise.	A series of negative pulses ½ cm apart (10 usec) and at least ½ cm (2½ volts) in amplitude.	Defective Q101 left or Q102 left. Defective component at Q101 left or Q102 left.
Standard 10-kc square wave.		STANDARD FREQUENCY HARMONICS selector to 10-kc. The STANDARD FREQUENCY HARMONICS 10-kc control maximum clockwise.	A series of negative pulses 5 cm apart and at least 2.9 cm in amplitude.	Defective Q101 right or Q102 right. Defective component at Q101 right or Q102 right.
Standard 100-kc and 10-kc square wave.		STANDARD FREQUENCY HARMONICS selector to STANDARD FREQUENCY HARMONICS 100/10 kc.	A series of negative pulses having twice the amplitude of the rest.	Defective Q101 left and right, Q102 left and right or associated circuitry.

2—20. Signal Substitution, Frequency Multiplier

Combined 10-mc output and 100-mc output signal substitution chart is as follows.

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
5 mc	Connect external signal to J1 and to the external frequency standard input of the electronic counter. The electronic counter is connected to J201, the 10-mc OUTPUT jack.	Turn the 10-mc increase OUTPUT control fully clockwise.	The electronic counter indicates 10-mc ±1 cycle.	
5 mc	Connect external signal to J1 and to the external frequency standard input of the electronic counter. The electronic counter is connected to J301, the 100-mc OUTPUT jack.	Turn the 100-mc increase OUTPUT control fully clockwise.	The electronic counter indicates 100-mc ±250 cycles.	

2–20. Signal Substitution, Frequency Multiplier—*CONTINUED*

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
5 mc	Connect external signal to J3 and to the external frequency standard input of the electronic counter.		The electronic counter indicates 10-mc.	Defective V200 or associated component.
	a. Connect the input of the electronic counter to terminal 2 of L201.			
	b. Connect the input of the counter to the shielded cable which is connected to J5.	Turn 10-mc increase OUTPUT control fully clockwise.	The electronic counter indicates 10-mc.	Defective CR220, CR221, V220, V240, Y200, or associated components.
10 mc	Remove Y200 and connect the external signal generator output to pin 1 of V260. Connect the input of the electronic counter to J201.		The electronic counter indicates 10-mc.	Defective V260 or associated component.
10 mc	Connect external signal to J5 and to the external frequency standard input of the electronic counter.		The electronic counter indicates 100-mc.	Defective V300 or associated component.
	a. Connect the input of the electronic counter to the junction of C307 and C308.			
	b. Connect the input of the electronic counter to the junction of C360 and C365 and remove Y300.		The electronic counter indicates 100-mc.	Defective CR320, V340, or associated component.
100 mc	Connect external signal to the junction of C360 and C365 and to the external frequency standard input of the electronic counter.	Turn 100-mc increase OUTPUT control fully clockwise.	The electronic counter indicates 100-mc.	Defective V361 or associated component.

2–20. Signal Substitution, Frequency Multiplier—*CONTINUED*

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
	a. Connect the input of the electronic counter to J301. *b.* Connect the input of the electronic counter to J4.		The electronic counter indicates 100-mc.	Defective V360 or associated component.

2–21. Signal Substitution, Frequency Calibrator

Signal frequency	Connections	Normal indication	Possible trouble
5 mc	Remove V201 and connect external signal to pin 7 of V204B and to the external frequency standard input of the electronic counter. Connect the electronic counter to J201.	The electronic counter indicates 5-mc.	Defective V204B or associated components.
5 mc	Remove V201 and connect external signal to pin 2 of V204A and to the external frequency standard input of the electronic counter. Connect the elcetronic counter to J201.	The electronic counter indicates 5-mc.	Defective V204A or associated components.
5 mc	Remove V201 and connect external signal to pin 2 of V203 and to the external frequency standard input of the electronic counter. Connect the electronic counter to pin 2 of V204A.	The electronic counter indicates 5-mc.	Defective V203 or associated components.
5 mc	Remove V201 and connect external signal to pin 2 of V202 and to the external frequency standard input of the electronic counter. Connect the electronic counter to pin 2 of V204A.	The electronic counter indicates 5-mc.	Defective V202, V203, or associated components.

2–22. Signal Substitution, Oscilloscope

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
100 cps at 1.5 volts.	Connect external signal to DET OUT jack, J6.	SELECTOR switch set to DET-INTERP.	2-inch vertical line on the screen.	Defective S2A rear, S2B rear, V3A, or associated components.
1 kc at 1.5 volts.	Connect external signal to DET OUT jack, J6.	SELECTOR switch set to DET-INTERP.	2-inch vertical line on the screen.	Defective S2A rear, S2B rear, V3A, or associated components.
10 kc at 1.5 volts.	Connect external signal to DET OUT jack, J6.	SELECTOR switch set to DET-INTERP.	2-inch vertical line on the screen.	Defective S2A rear, S2B rear, V3A, or associated components.
100 cps at 2.6 volts.	Connect external signal to INTERP-OUT jack, J5.	SELECTOR switch set to DET-INTERP.	2-inch horizontal line on the screen.	Defective S2A rear, V3B, or associated components.

2–22. Signal Substitution, Oscilloscope—*CONTINUED*

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
1 kc at 2.1 volts.	Connect external signal to INTERP-OUT jack, J5.	SELECTOR switch set to DET-INTERP.	2-inch horizontal line on the screen.	Defective S2A rear, S2B rear, V3B or associated components.
10 kc at 3.5 volts.	Connect external signal to INTERP-OUT jack, J5.	SELECTOR switch set to DET-INTERP.	2-inch horizontal line on the screen.	Defective S2A rear, S2B rear, V3B, or associated components.
100 cps at 2 volts.	Connect external signal to 100 jack, J4.	SELECTOR switch set to X-STD CIRC SW. CIRCULAR SWEEP FREQUENCY switch set to 100 DIAMETER control positioned fully clockwise.	Obtain a circular sweep pattern and then vary the frequency of the signal generator for maximum diameter of the pattern. This should occur between 90 and 100 cps.	Defective V1, V2 or associated components; or defective S2A, S1E, S1D, S1C, S1B, S1A, C7, L1, C13, or C18.
1 kc at .2 volt.	Connect external signal to 1 kc jack, J3.	SELECTOR switch set to X-STD CIRC SW. CIRCULAR SWEEP FREQUENCY switch set to 1 kc. DIAMETER control positioned fully clockwise.	Obtain a circular sweep pattern, and then vary the signal generator frequency for maximum diameter of the pattern. This should occur between 900 and 1,100 cycles.	Defective V1, V2, or associated components; or defective S1E, S1D, S1B, S1A, C8, L2, C14, or C19.
10 kc at .2 volt.	Connect external signal to 10 kc jack, J2.	SELECTOR switch set to X-STD CIRC SW. CIRCULAR SWEEP FREQUENCY switch set to 10-kc. DIAMETER control positioned fully clockwise.	Obtain a circular sweep pattern and then vary the signal generator frequency for maximum diameter of the pattern. This should occur between 9 kc and 11 kc.	Defective V1, V2, or associated components; or defective S1E, S1D, S1B, S1A, L3, C9, C15, or C20.
3,500 cps at 2 volt.	Connect external signal to INTERP-OUT jack, J5.	CIRCULAR SWEEP FREQUENCY switch to INTERP OSC. SELECTOR switch to DET-INTERP position.	Varying the SHAPING control will vary the height of the pattern without tipping the presentation to either side.	Defective V3B, V2, C16, C21, V3A, R10, or R11. Defective component at V3A, V3B, or V2.
300 cycles at .2 volt.	Connect external signal to input jack, X, J1.	SELECTOR switch set to X-STD CIRC SW. CIRCULAR SWEEP FREQUENCY switch set to LINE.	Obtain a 5 pointed pattern on the screen. Vary the input voltage to see that the over-loading of the flattening of the peaks occurs at not less than 0.35 volt of input.	Defective V4A, V4B, or associated components; or defective S2B, S1E, S1D, S1B, C6, C12, or C17.

2–23. Signal Substitution, Signal Generator

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
5,000 cps	Connect external signal to pin 4 of V6B. Connect headphones to J4. Remove V1, V2, V3, and V4.	ON-OFF power switch to ON.	Hear 5,000-cycle note in headphones.	Defective V6B or associated components.
5,000 cps	Connect external signal to pin 4 of V5B.		Hear 5,000-cycle note in headphones.	Defective V5B or associated components.
5,000 cps	Connect external signal to pin 1 of V6A.	Turn OUTPUT control completely clockwise. Turn input control completely counterclockwise.	Hear 5,000-cycle note in headphones.	Defective V6A or associated components.
5,000 cps	Connect one external signal to pin 1 of V6A and another external signal to J3.	Turn INPUT control completely clockwise.	Zero beat occurs. Adjust frequency at one of the input signals to confirm zero beat.	Defective V6A, V7, or associated components.
47 kc	Connect external signal to the junction of R17 and C25. Replace V1 and V2.	*a.* Turn the REVERSE-DIRECT switch to REVERSE.	Assuming that the preceding steps have been followed and found to be normal. Zero beat occurs. Adjust frequency of external signal to confirm zero beat.	Defective V1, V2, V5A, or associated components.
		b. Turn the REVERSE-DIRECT switch to DIRECT.	Assuming that preceding steps have been followed and found to be normal. Hear 5,000-cycle note in the headphones.	Defective V1, V2, or associated components.
47 kc	The junction R17 and C25. Connect headphones to J4. Replace V3 and V4 and remove V1 and V2.	*a.* Position FREQUENCY dials to indicate zero frequency.	Assuming that the preceding steps have been followed and found to be normal. Hear 5,000-cycle note in the headphones.	Defective V3, V4, or associated components.
		b. Position the FREQUENCY dial to indicate 5,000-cycles per second.	Assuming that the preceding steps have been followed and found to be normal. Hear zero beat in the headphones. Vary frequency of external signal to confirm zero beat.	Defective V3, V4, or associated components.

2—24. Signal Substitution, FR—43A/URM—18

Signal frequency	Corrections	Switch and control settings	Normal indication	Possible trouble
1,000 cps	Connect external signal to pin 4 of V8B. Connect headphones to DETECTOR OUTPUT jack, J3.		Hear 1,000-cycle note in the headphones.	Defective V8B or associated components.
1,000 cps	Connect external signal to pin 1 of V8A.		Hear 1,000-cycle note in the headphones.	Defective V8A or associated components.
1,000 cps	Connect external signal to pin 5 of V7.		Hear 1,000-cycle note in the headphones.	Defective V7 or associated components.
		For each change of signal frequency, adjust the detector section dials for the frequency listed and adjust the REGENERATION control to a point where oscillation just occurs.	For each signal frequency listed, zero beat occurs. In each case, vary the signal frequency to confirm zero beat.	
121 kc	Connect external signal to DETECTOR INPUT jack, J2. Connect headphones pin 5 of V7.	121 kc		Defective V6 or associated components; defective S4D, S4A, L8A, or L8B.
170.5 kc		170.5 kc		Defective S4D, S4A, L9A, or L9B.
241 kc		241 kc		Defective L10A, L10B, S4D, or S4A.
341 kc		341 kc		Defective L11A, L11B, S4D, or S4A.
482 kc		482 kc		Defective L12B, L12A, S4D, or S4A.
602.5 kc		602.5 kc		Defective L13A, L13B, S4D, or S4A.
852.5 kc		852.5 kc		Defective L14A, L14B, S4D, or S4A.
1,205 kc		1,205 kc		Defective L15B, L15A, S4D, or S4A.
1,705 kc		1,705 kc		Defective L16A, L16B, S4D, or S4A.

2–24. Signal Substitution, FR–43A/URM–18—*CONTINUED*

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
100 kc	Connect external signal to pin 4 of V2. Connect FREQUENCY METER OUTPUT jack, J1 to DETECTOR INPUT jack, J2. Connect headphones to DETECTOR OUTPUT jack, J3. Remove V1.	100 kc		Defective V2, V3, or associated components.

2–25. Signal Substitution, FR–44/URM–18

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
1,000 cps	Connect external signal to pin 4 of V8B. Connect headphones to DETECTOR OUTPUT jack, J3.		Hear 1,000-cycle note in the headphones.	Defective V8B or associated components.
1,000 cps	Connect external signal to pin 1 of V8A.		Hear 1,000-cycle note in the headphones.	Defective V8A or associated components.
1,000 cps	Connect external signal to pin 5 of V7.		Hear 1,000-cycle note in the headphones.	Defective V7 or associated components.
		For each change of signal frequency, adjust the detector section dials for the frequency listed and adjust the REGENERATION control to a point where oscillation just occurs.	For each signal frequency listed, zero beat occurs. In each case, vary the signal frequency to confirm zero beat.	
1.13 mc	Connect external signal to DETECTOR INPUT jack, J2. Connect headphones to pin 5 of V7. Continue these connections to and including signal frequency 8.97 mc.	1.13 mc		Defective V6, or associated components. Defective L8A, L8B, S4A, S4D, C30, or C30A.
1.44 mc		1.44 mc		Defective L9A, L9B, S4A, or S4D.
1.79 mc		1.79 mc		Defective L10A, L10B, S4A, or S4D.

2–25. Signal Substitution, FR–44/URM–18—*CONTINUED*

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
2.26 mc		2.26 mc		Defective L11A, L11B, S4A, or S4D.
6.7 mc		6.7 mc		Defective L11A, L11B, S4A, S4D.
3.59 mc		3.59 mc		Defective L12A, L12B, S4A, or S4D.
4.5 mc		4.5 mc		Defective L13A, L13B, S4A, or S4D.
5.65 mc		5.65 mc		Defective L14A, L14B, S4A, or S4D.
7.22 mc		7.22 mc		Defective L15A, L15B, S4A, or S4D.
8.97 mc		8.97 mc		Defective L16A, L16B, S4A, or S4D.
1.0 mc	Connect external signal to pin 4 of V2. Connect FREQ METER OUTPUT jack J1, to DETECTOR INPUT jack, J2. Connect headphones to DETECTOR OUTPUT jack, J3. Remove V1.	1.0 mc		Defective V2, V3, or associated components.

2–26. Signal Substitution, FR–45A/URM–18

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
1,000 cps	Connect external signal to pin 4 of V8B. Connect headphones to DETECTOR OUTPUT jack J3.		Hear 1,000-cycle note in the headphones.	Defective V8B or associated components.
1,000 cps	Connect external signal to pin 1 of V8A. Connect headphones to DETECTOR OUTPUT jack J3.		Hear 1,000-cycle note in the headphones.	Defective V8A or associated components.
1,000 cps	Connect external signal to pin 5 of V7. Connect headphones to DETECTOR OUTPUT jack J3.		Hear 1,000-cycle note in the headphones.	Defective V7 or associated components.

2–26. Signal Substitution, FR–45A/URM–18—*CONTINUED*

Signal frequency	Connections	Switch and control settings	Normal indication	Possible trouble
		For each change of signal frequency, adjust the detector section dials for the frequency listed and adjust the REGENERATION control to a point where oscillation just occurs.	For each signal frequency listed, zero beat occurs. In each case, vary the signal frequency to confirm zero beat.	
11.3 mc	Connect external signal to DETECTOR INPUT jack J2. Connect headphones to pin 5 of V7. Continue these connections to and including signal frequency 87.75 mc.	11.3 mc		Defective V6 or associated components; defective L8, S4A, or S4B.
14. 25 mc		14.25 mc		Defective L9, S4A, or S4B.
17.95 mc		17.95 mc		Defective L10, S4A, or S4B.
22.6 mc		22.6 mc		Defective L11, S4A, or S4B.
28.5 mc		28.5 mc		Defective L12, S4A, or S4B.
35.9 mc		35.9 mc		Defective L13, S4A, or S4B.
45.0 mc		45.0 mc		Defective L14, S4A, or S4B.
56.5 mc		56.5 mc		Defective L15, S4A, or S4B.
71.25 mc		71.25 mc		Defective L16, S4A, or S4B.
87.75 mc		87.75 mc		Defective L17, S4A, or S4B.
10 mc	Connect external signal to pin 1 of V2. Connect FREQUENCY METER OUTPUT jack, J1 to DETECTOR INPUT jack, J2. Connect headphones to DETECTOR OUTPUT jack, J3. Remove V1.	10 mc		Defective V2, V3, or associated components.

2—27. Signal Substitution, Frequency Divider

Note. In the following tests, in the signal substitution chart, the type 1114-P9 extension cable is used to connect the plug-in unit under test to the main chassis. No other external signals are to be connected to the frequency divider except those indicated in the chart. All connections are to plug-in units.

Signal frequency	Connections	Normal indication	Possible trouble
5-mc at 1-volt output	*a.* Connect external signal to J102, plug-in unit 1114-P1. Connect oscilloscope to TP101. Connect 50-ohm termination to J101.	*a.* Observe 4-mc sine wave approximately 2 volts peak to peak, with a 1-mc envelope approximately .2 volt peak to peak.	*a.* Defective Q101, Q103, or associated components.
	b. Connect oscilloscope to J101.	*b.* Observe 1-mc sine wave approximately 2.7 volts peak to peak.	*b.* Defective Q102 or associated components.
	c. Connect oscilloscope to terminal 16. Connect 50-ohm termination to J101.	*c.* Observe 1-mc sine wave.	*c.* Defective Q104 or associated components.
1-mc square wave	*a.* Connect external signal to terminal 23, plug-in unit 1114-P2. Connect oscilloscope to TP201.	*a.* Observe that a negative pulse starts at every fourth positive pulse.	*a.* Defective Q201, Q202, Q203, or associated components; R208 maladjusted.
	b. Connect oscilloscope to terminal 26.	*b.* Assuming that the previous step was found normal, observe a 100-kc square wave.	*b.* Defective Q204, Q205, or associated components.
	c. Connect oscilloscope to J202.	*c.* Assuming that the previous steps were found normal, observe a 100-kc square wave.	*c.* Defective Q208 or associated components.
100-kc square wave	*a.* Connect external signal to terminal 35, plug-in unit 1114-P3. Connect oscilloscope to TP301.	*a.* Observe that a negative pulse starts at every fourth positive pulse.	*a.* Defective Q301, Q302, Q303, or associated components.
	b. Connect oscilloscope to terminal 33.	*b.* Assuming that the previous step was found to be normal, observe a 10-kc square-wave output.	*b.* Defective Q304, Q305, or associated components.
	c. Connect oscilloscope to J302.	*c.* Assuming that the previous steps were found to be normal, observe a 10-kc square wave.	*c.* Defective Q308, or associated components.
	d. Connect oscilloscope to J301.	*d.* Assuming that the previous steps were found to be normal, observe a 10-kc sine wave.	*d.* Defective LC301, Q306, Q307, or associated components.
10-kc square wave	*a.* Connect external signal to terminal 43, plug-in unit 1114-P4. Connect oscilloscope to TP401.	*a.* Observe that a negative pulse starts at every fourth positive pulse.	*a.* Defective Q401, Q402, Q403, or associated components. R408 maladjusted.

2–27. Signal Substitution, Frequency Divider—*CONTINUED*

Signal frequency	Connections	Normal indication	Possible trouble
	b. Connect oscilloscope to terminal 42.	*b.* Assuming that the previous step was found to be normal, observe a 1-kc square-wave output.	*b.* Defective Q404, Q405, or associated components.
	c. Connect oscilloscope to J401.	*c.* Assuming that the previous steps were found to be normal, observe 1-kc sine-wave output.	*c.* Defective LC401, Q406, Q407, or associated components.
	d. Connect oscilloscope to J402.	*d.* Assuming that the previous steps were found to be normal, observe a 1-kc sine-wave output.	*d.* Defective Q408, Q409, or associated components.
1-kc square wave	*a.* Connect external signal to terminal 52, plug-in unit 1114-P5. Connect oscilloscope to TP501.	*a.* Observe that a negative pulse starts at every fourth positive pulse.	*a.* Defective Q501, Q502, Q503, or associated components.
	b. Connect oscilloscope to terminal 56.	*b.* Assuming that the previous step was found to be normal, observe a series of negative pulses, 200 cycles in frequency.	*b.* Defective Q504 or associated components.
	c. Connect oscilloscope to terminal 55.	*c.* Assuming that the previous steps were found to be normal, observe a 100-cycle square-wave output.	*c.* Defective Q505, Q506, Q507, or associated components.
	d. Connect oscilloscope to J501.	*d.* Assuming that the previous steps were found to be normal, observe a 100-cycle sine-wave output.	*d.* Defective Q508, Q509, or associated components.

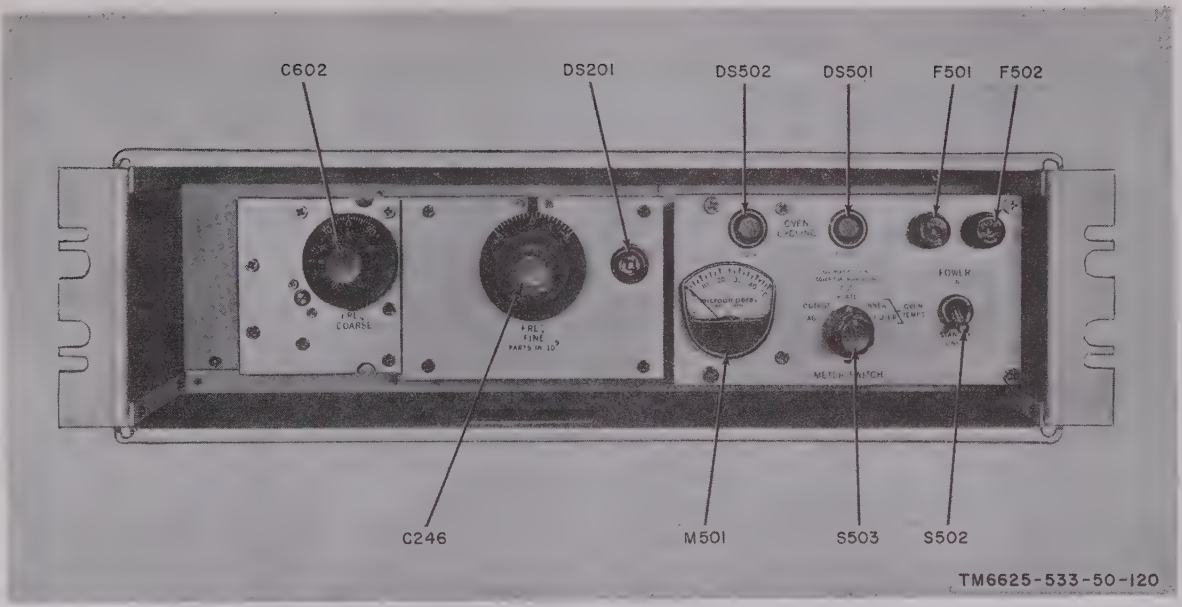


Figure 2–1. Standard Frequency Oscillator O–1106/URM–18A, front view with outer panel removed.

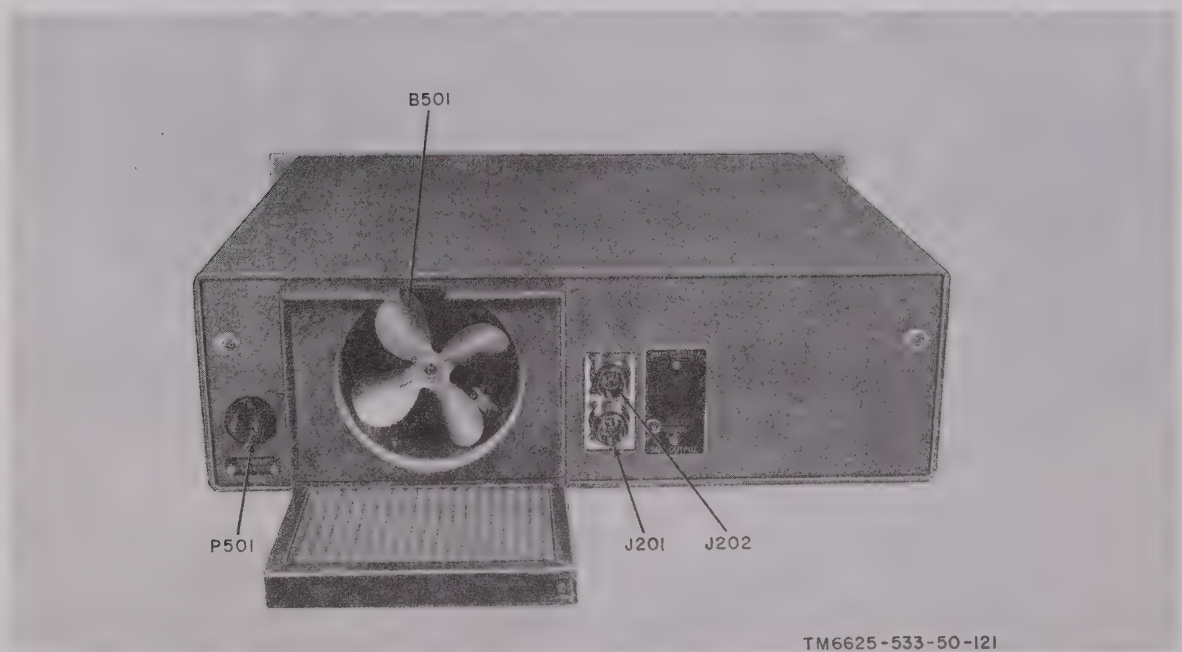


Figure 2–2. Standard Frequency Oscillator O–1106/URM–18A, rear view.

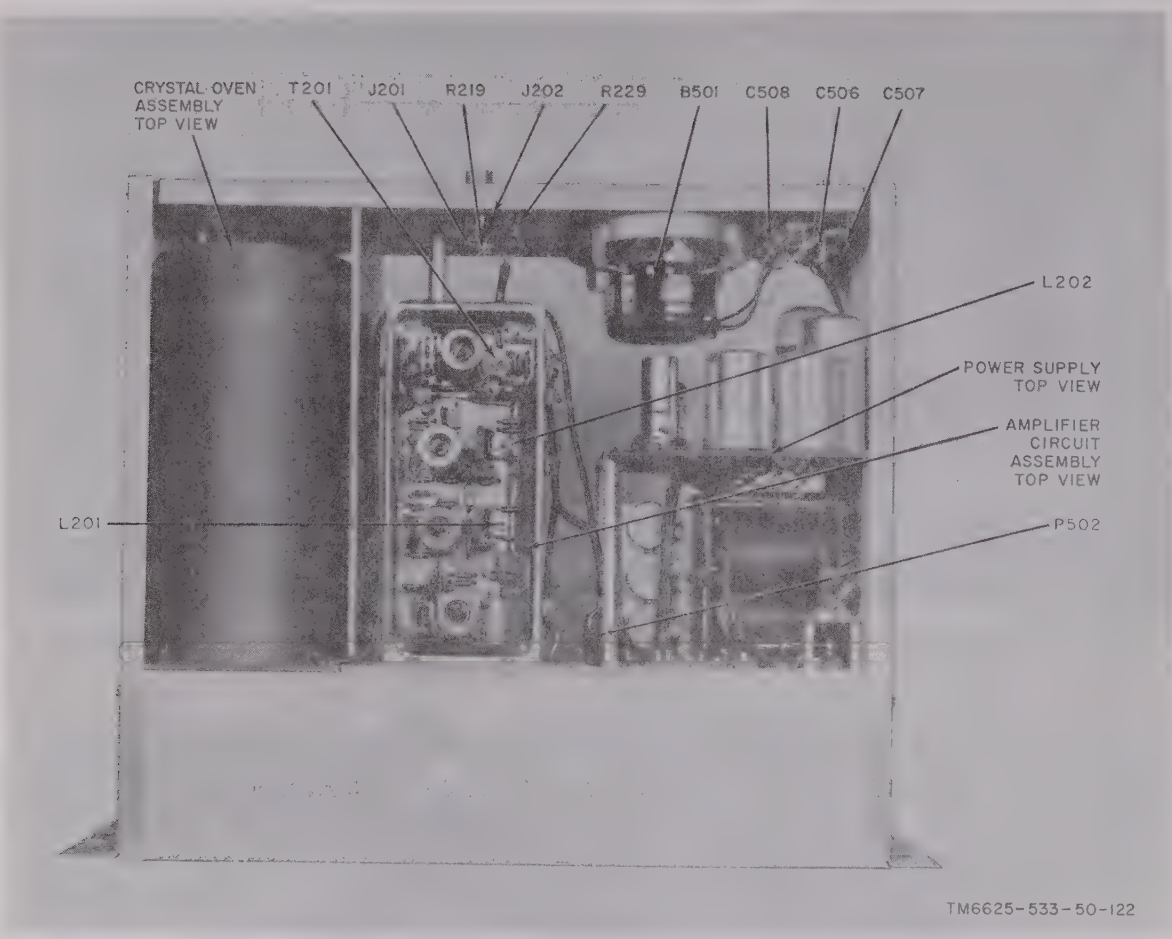


Figure 2–3. Standard Frequency Oscillator O–1106/URM–18A, top view with top cover removed.

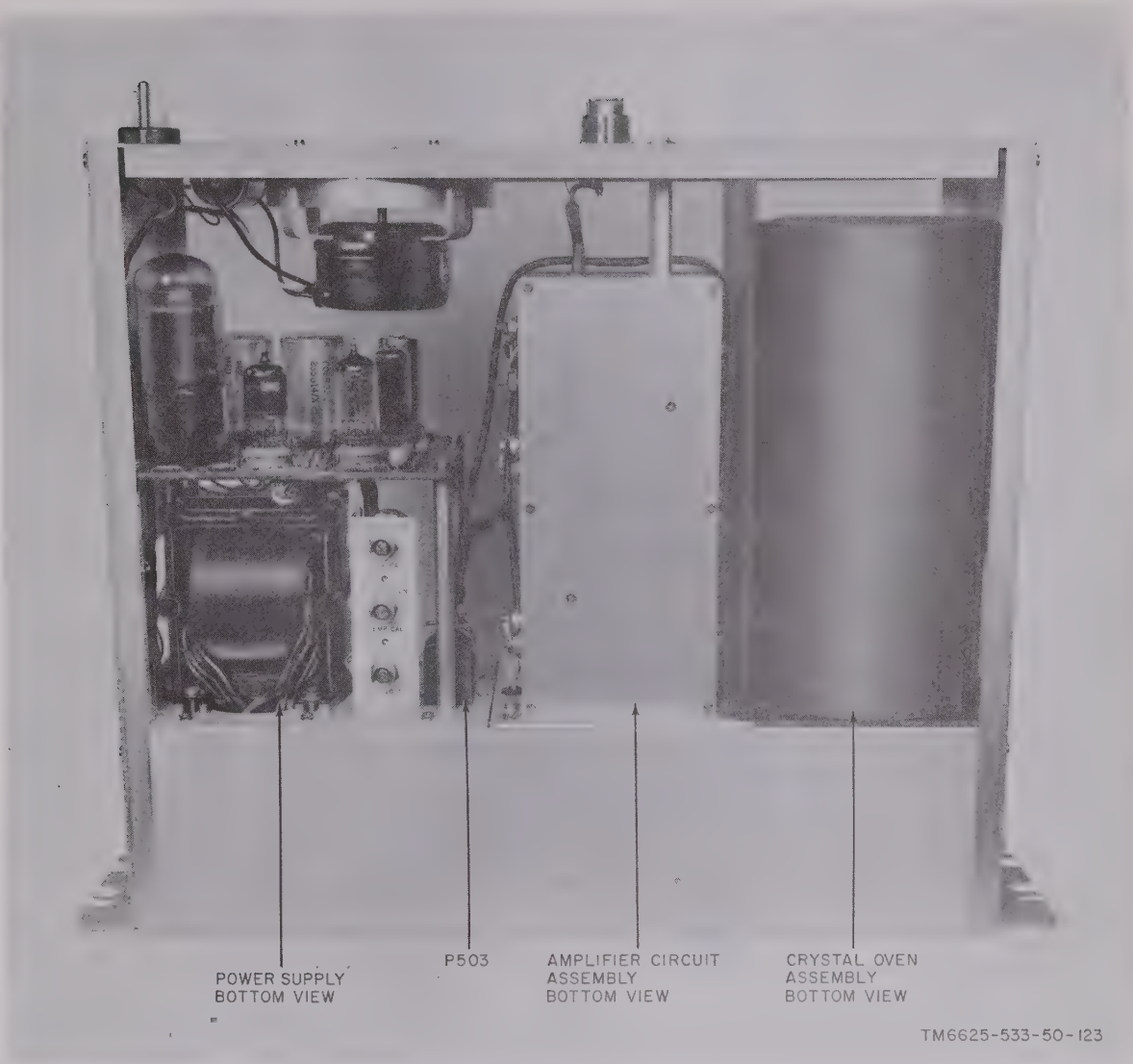


Figure 2–4. Standard Frequency Oscillator O–1106/URM–18A, bottom view with cover removed.

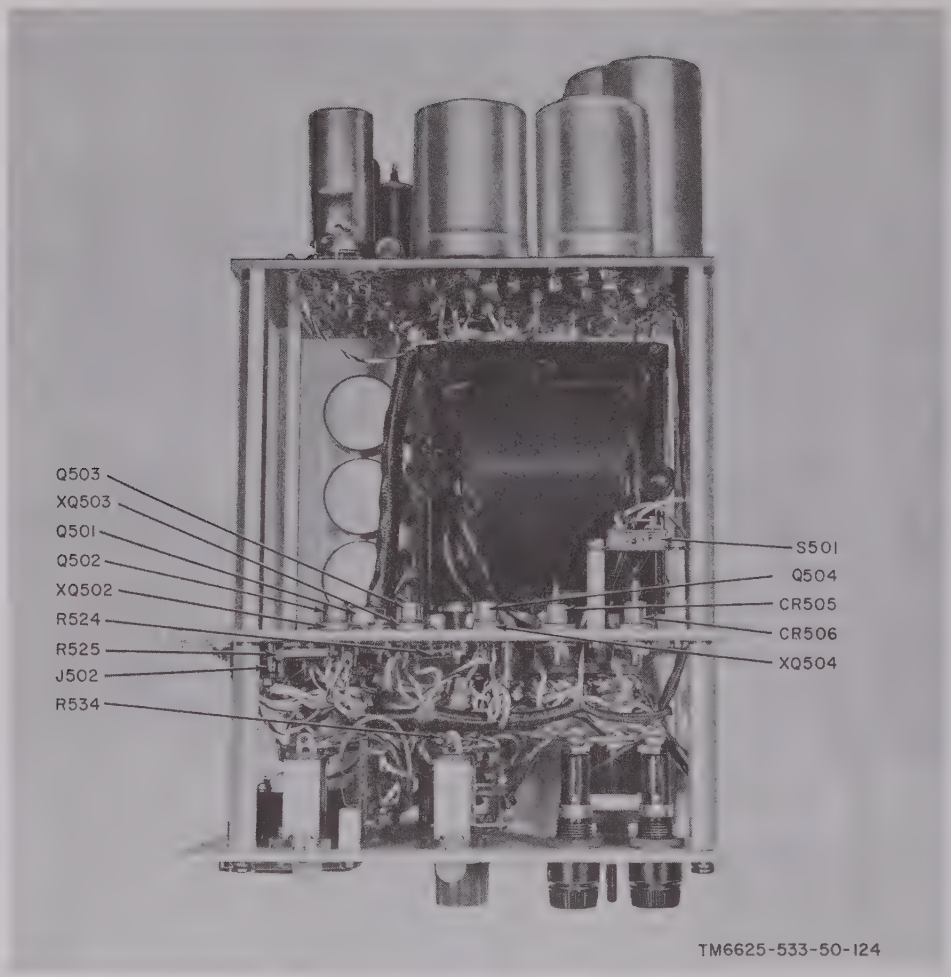


Figure 2–5. Standard Frequency Oscillator O–1106/URM–18A, power supply circuit assembly panel, top view.

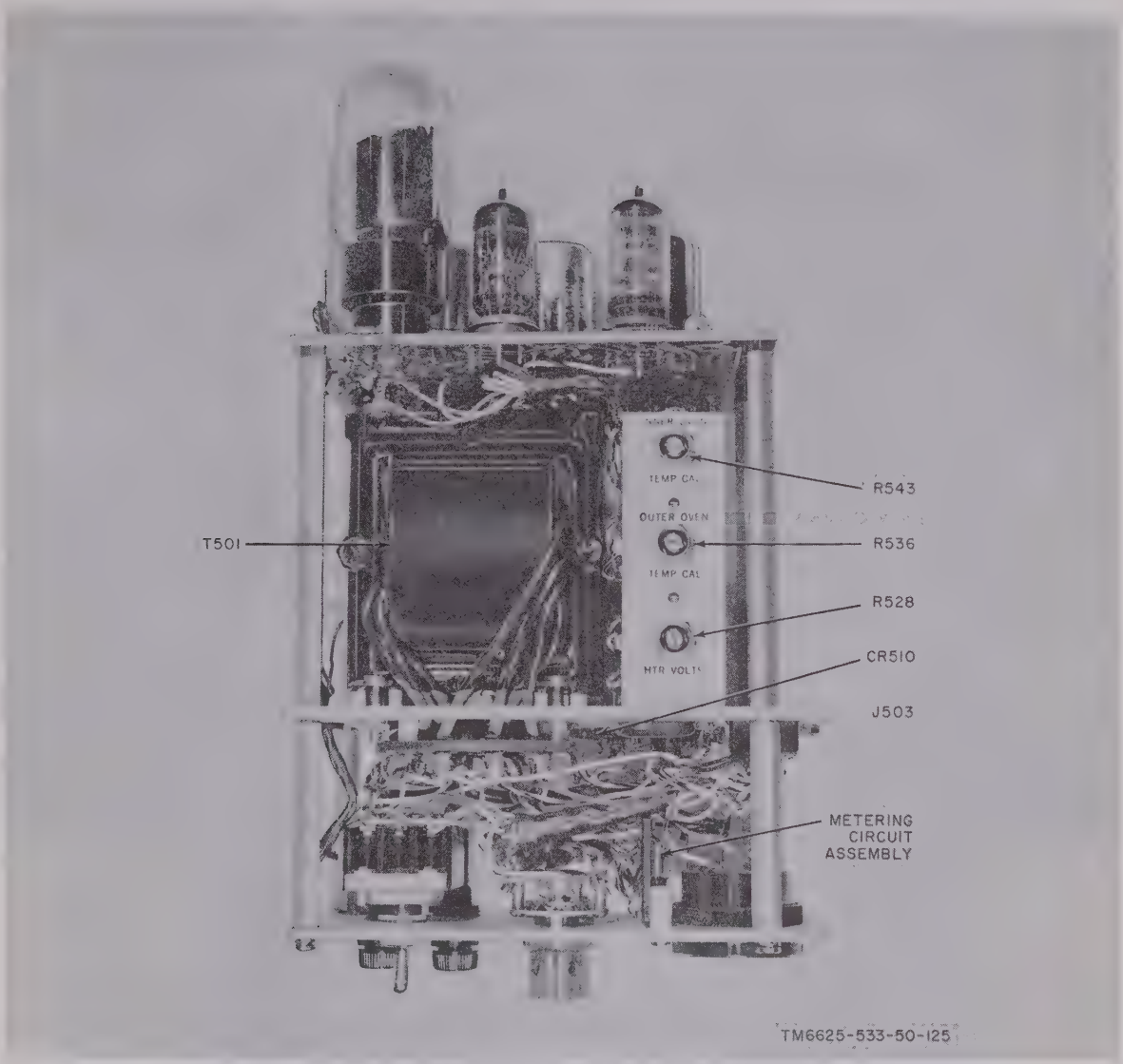


Figure 2–6. Standard Frequency Oscillator O–1106/URM–18A, power supply circuit assembly panel, bottom view.

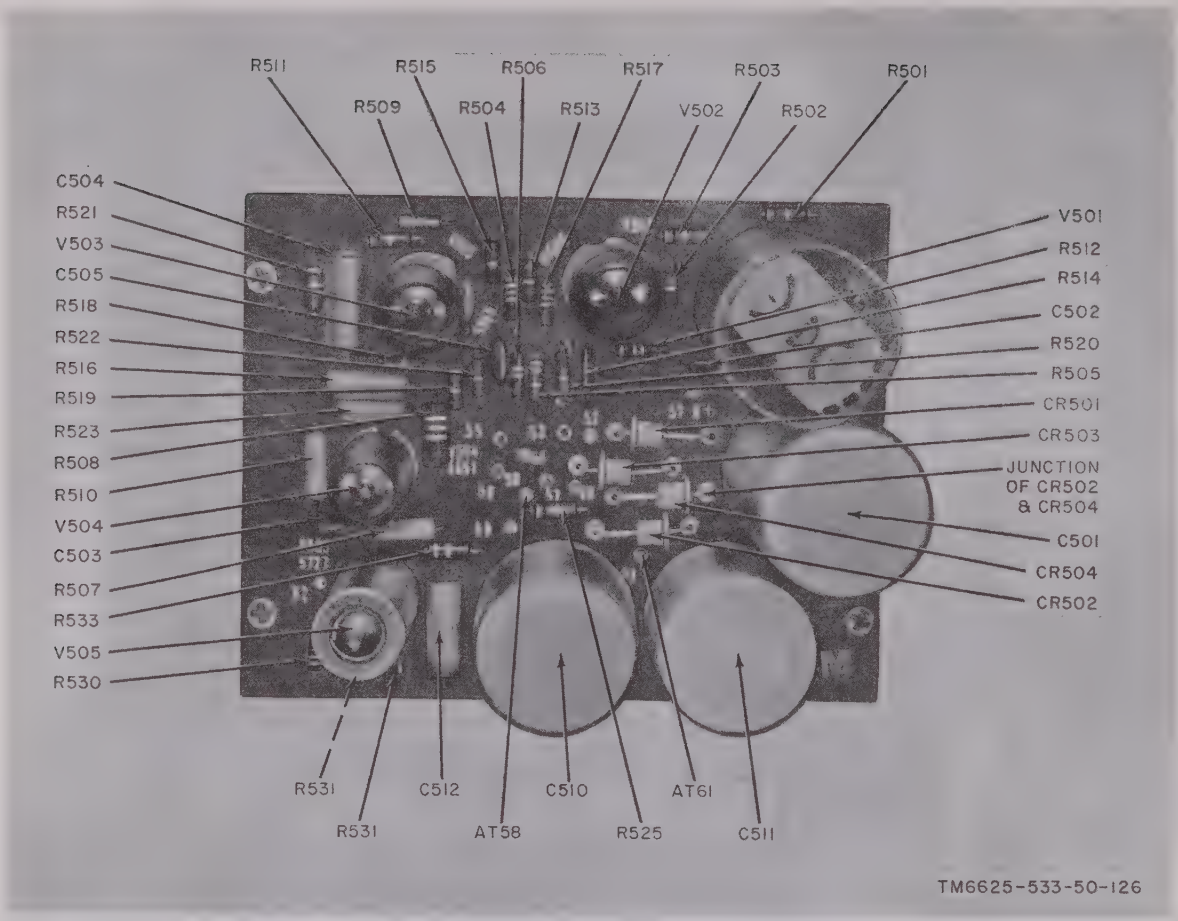


Figure 2–7. Standard Frequency Oscillator O–1106/URM–18A, power supply rear view.

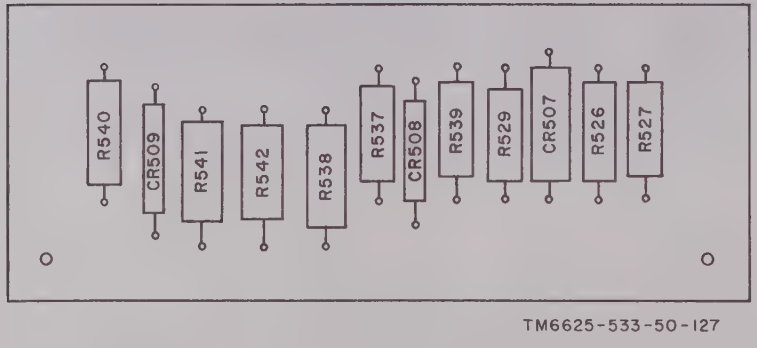


Figure 2–8. Standard Frequency Oscillator O–1106/URM–18A, metering circuit assembly.

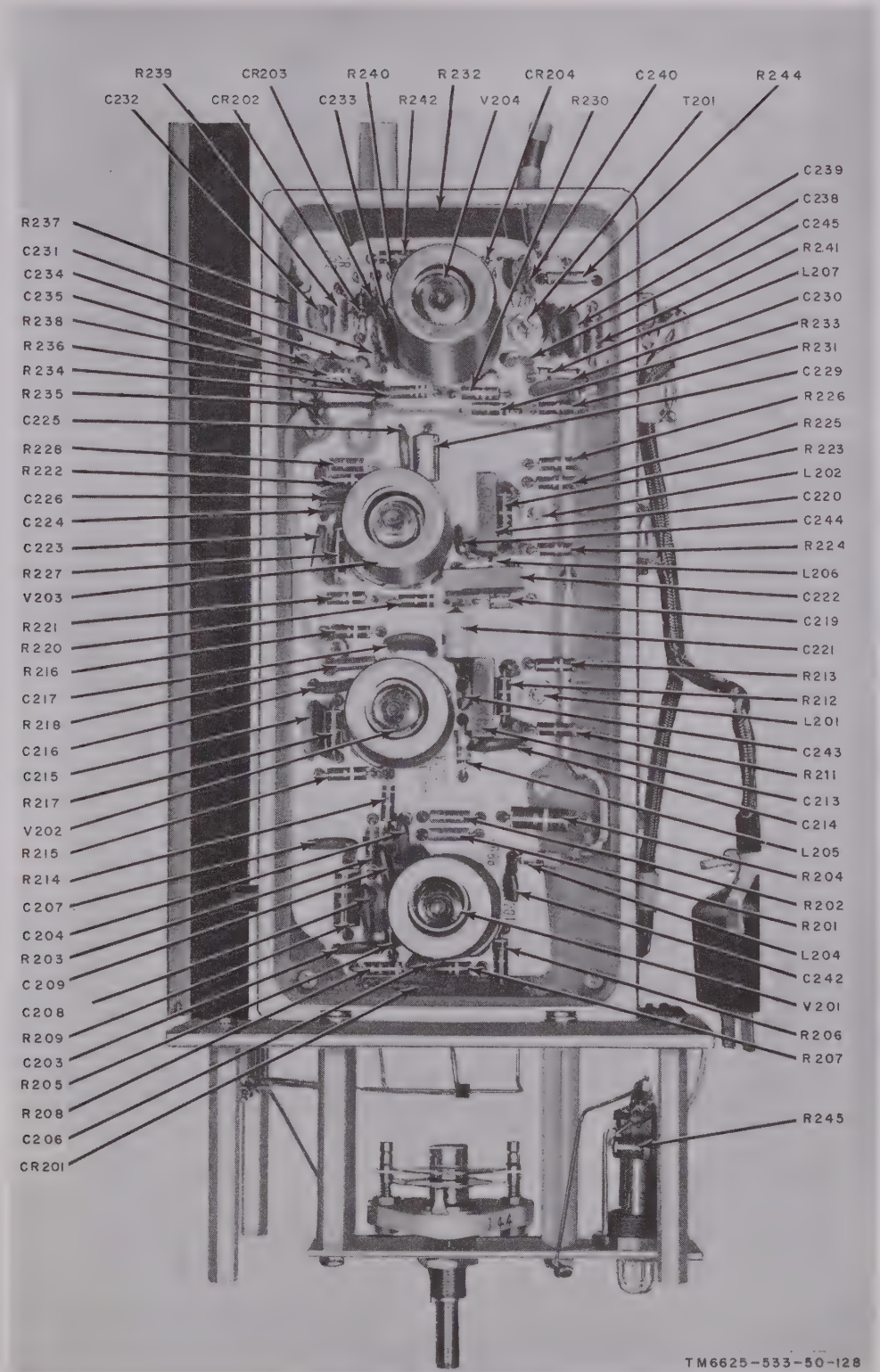


Figure 2–9. Standard Frequency Oscillator O–1106/URM–18A, oscillator amplifier circuit, top view.

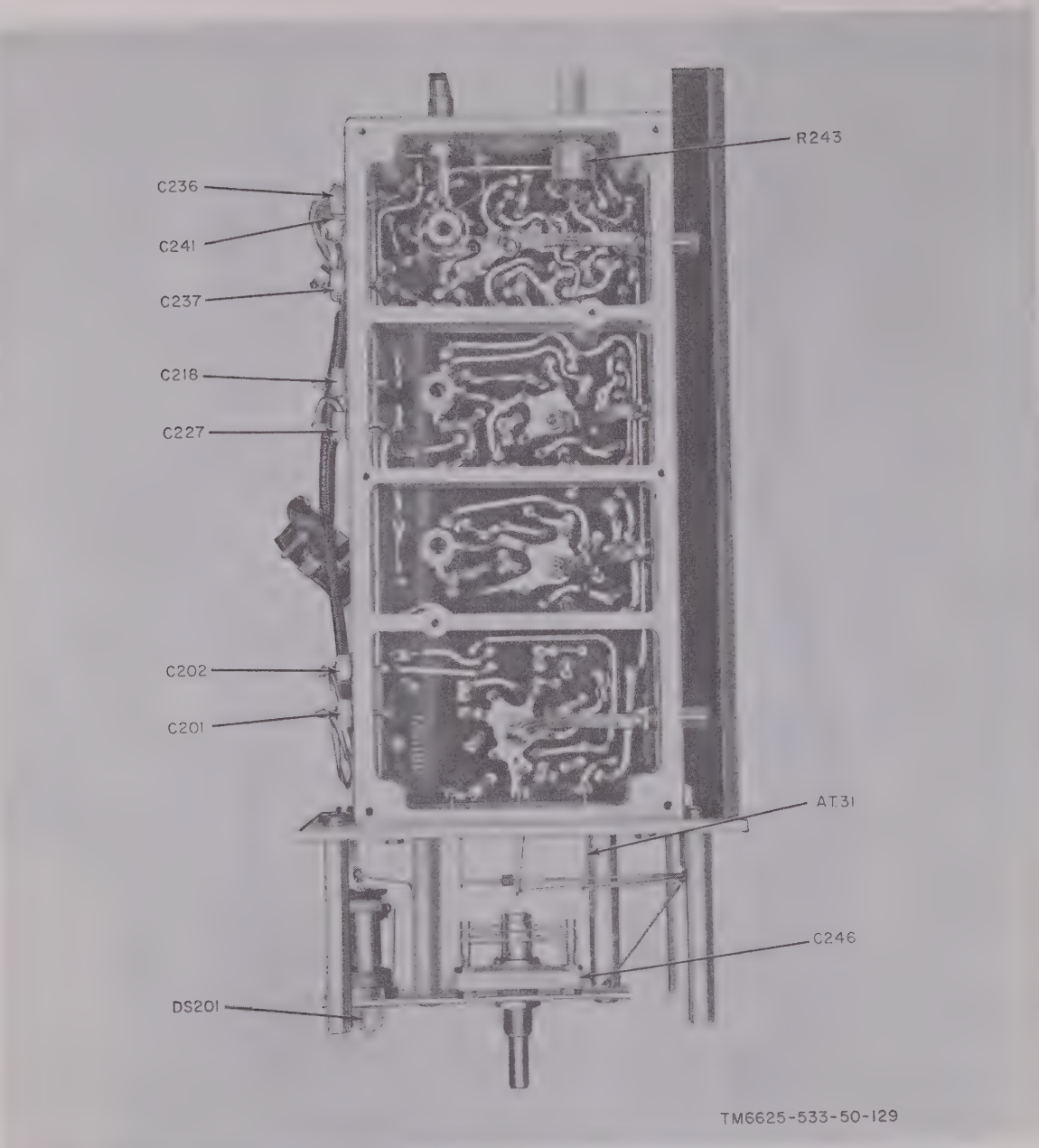


Figure 2–10. Standard Frequency Oscillator O–1106/URM–18A, oscillator amplifier circuit, bottom view.

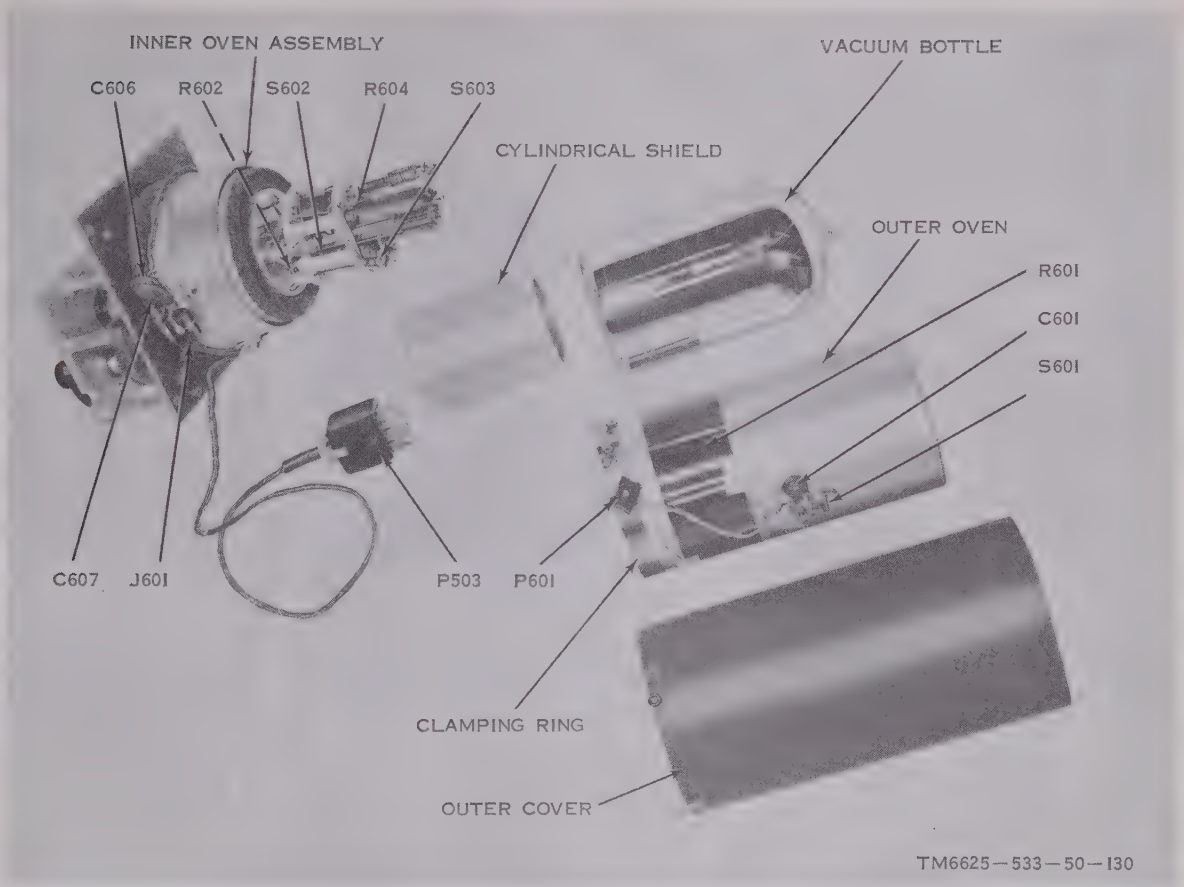


Figure 2–11. Standard Frequency Oscillator O–1106/URM–18A, crystal oven assembly.

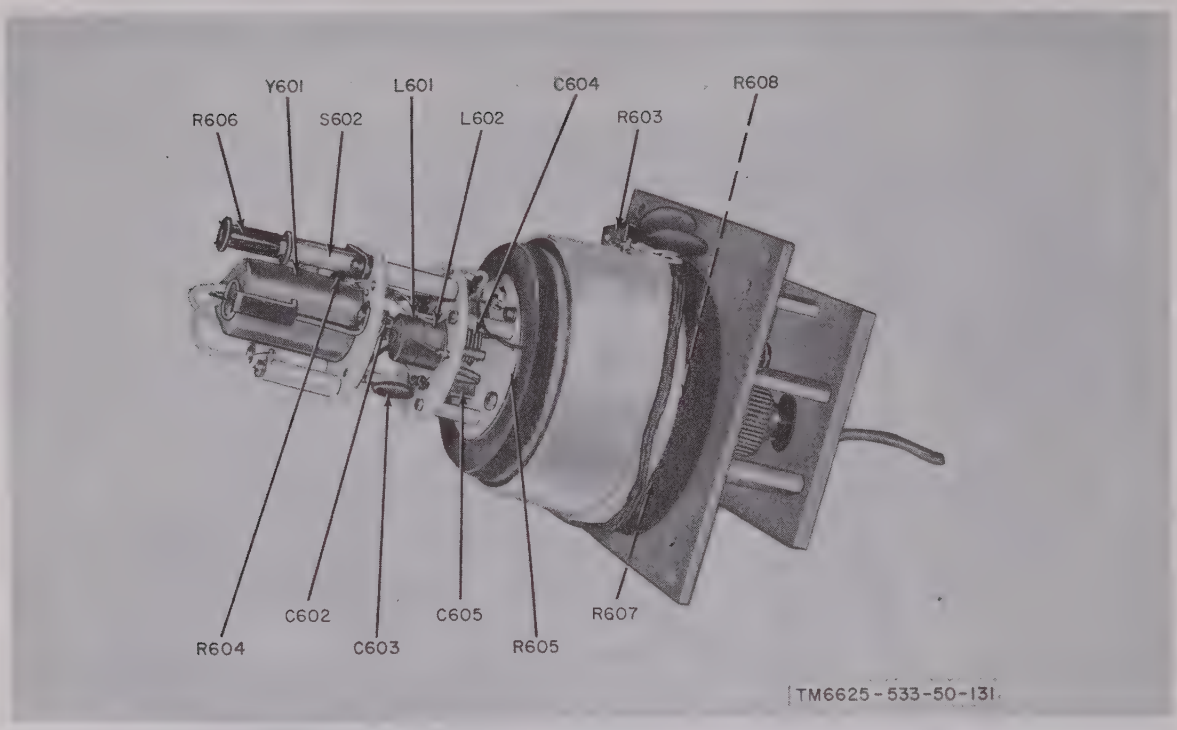


Figure 2–12. Standard Frequency Oscillator O–1106/URM–18A, inner oven assembly.

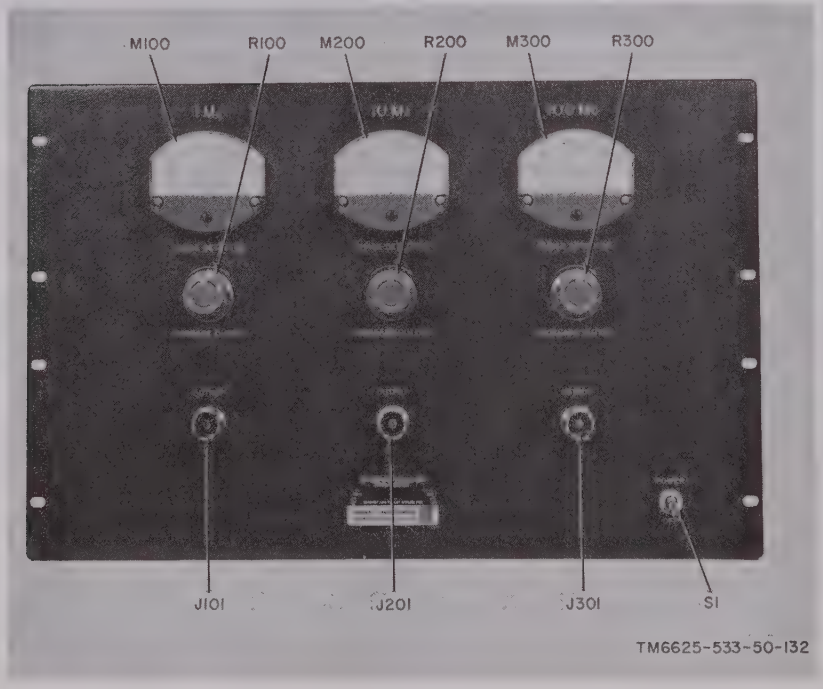


Figure 2–13. Frequency Multiplier CV–1518/URM–18A, front view.

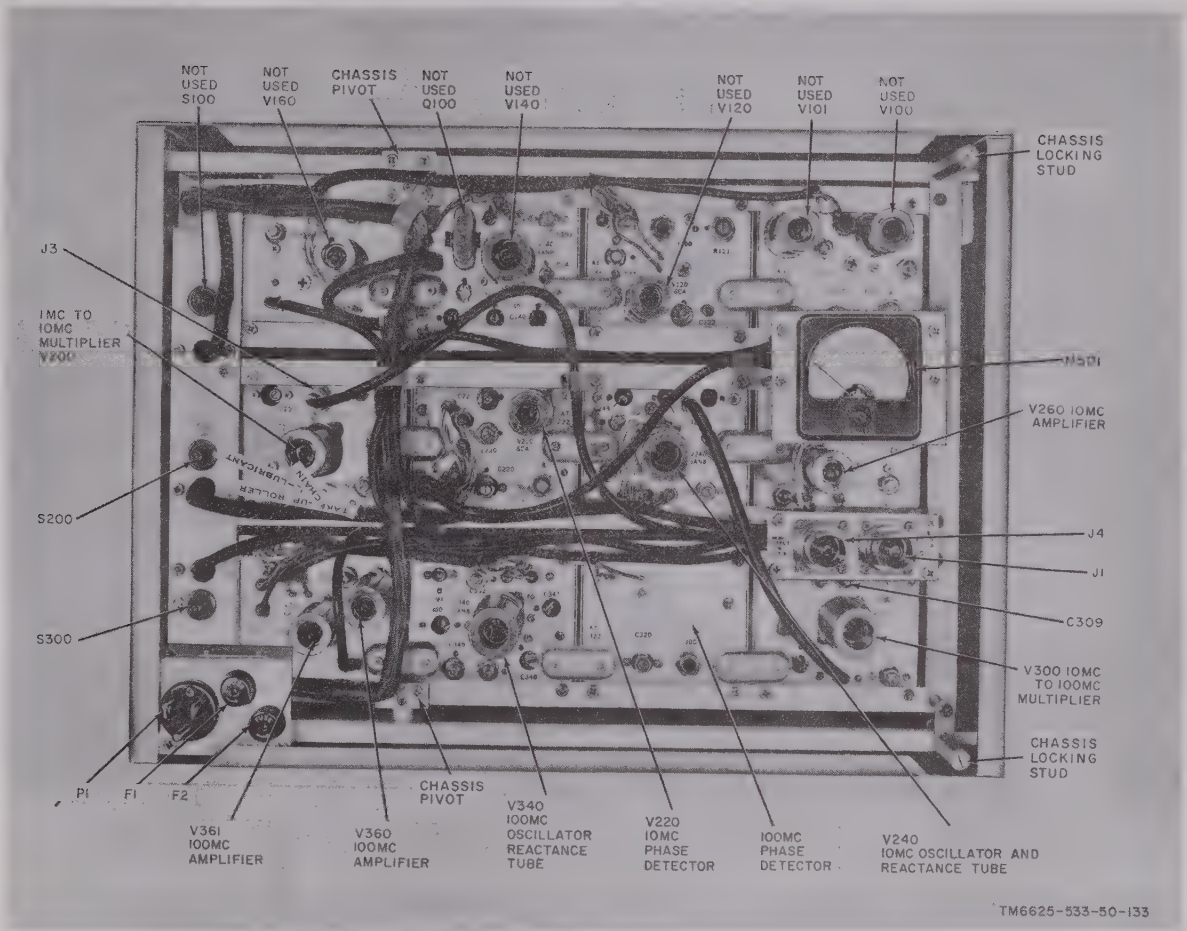


Figure 2–14. Frequency Multiplier CV–1518/URM–18A, rear view with rear panel showing decade shelf assembly.

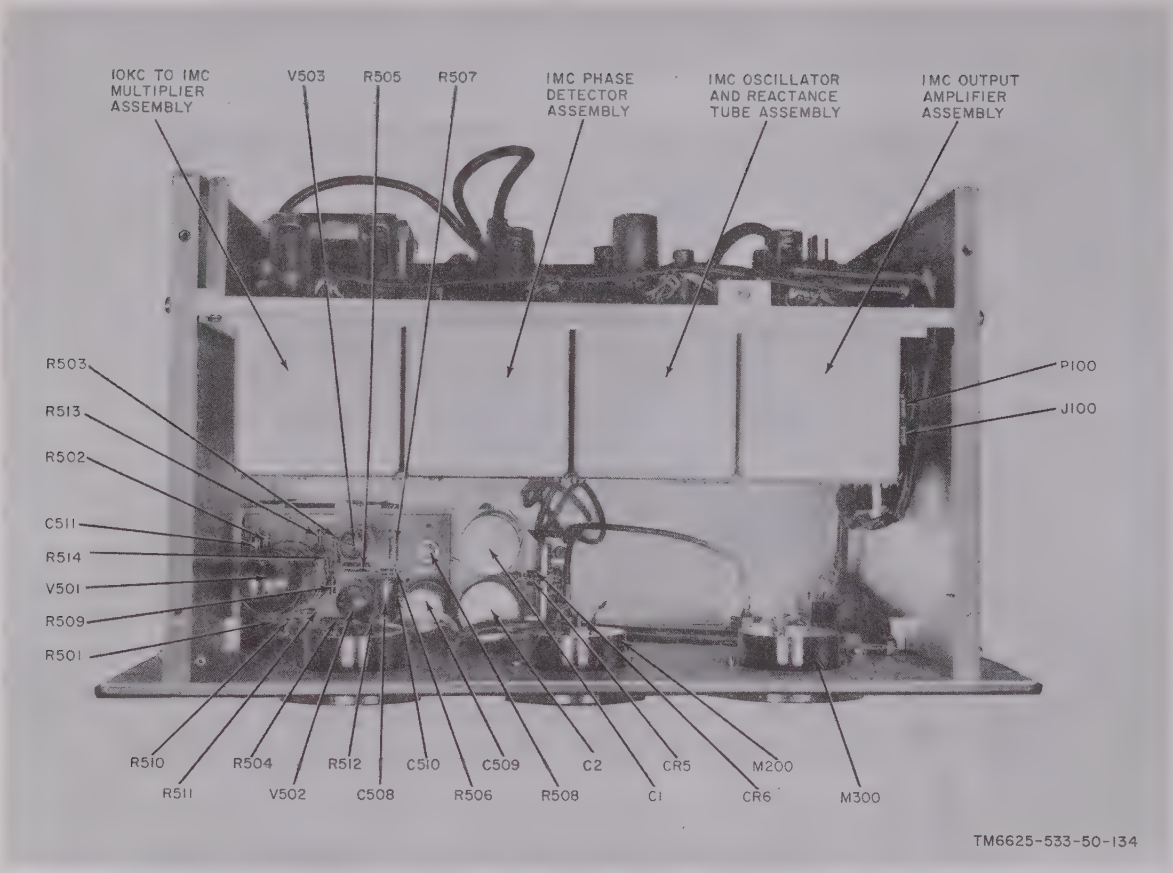


Figure 2–15. Frequency Multiplier CV–1518/URM–18A, top view.

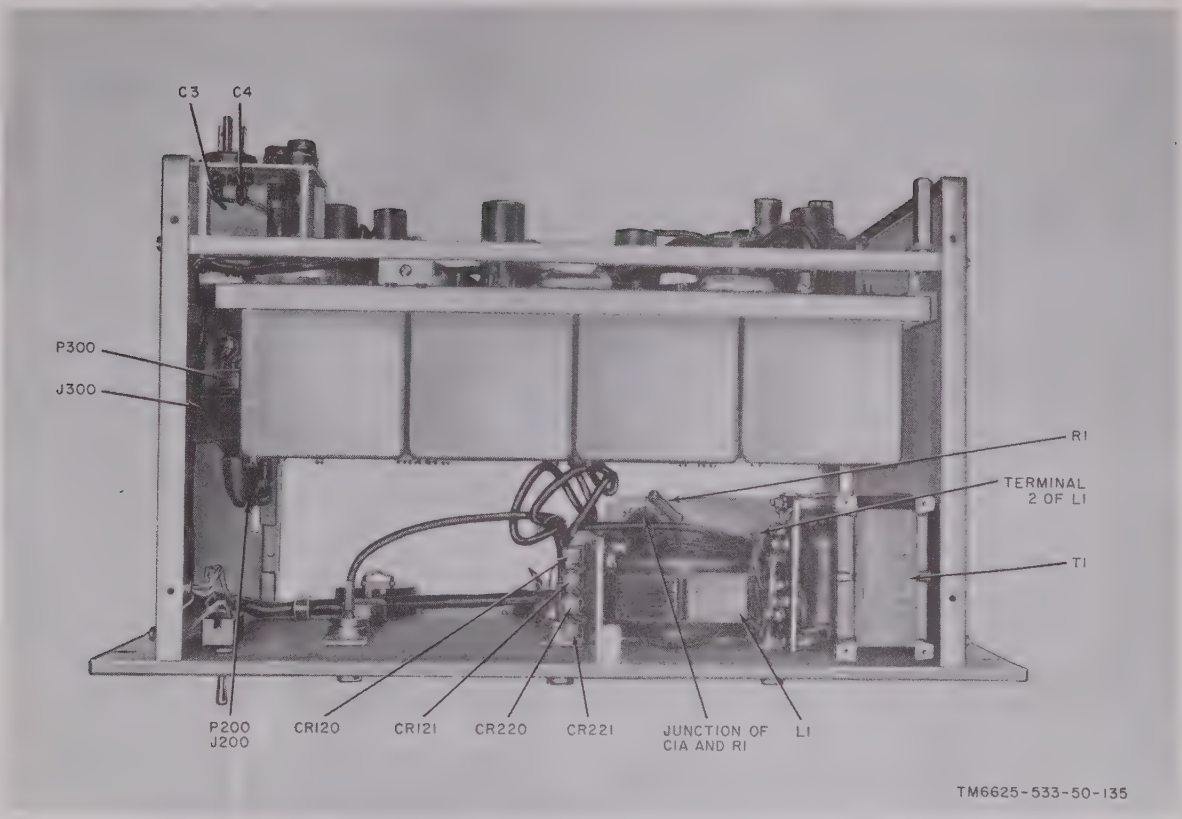


Figure 2–16. Frequency Multiplier CV–1518/URM–18A, bottom view.

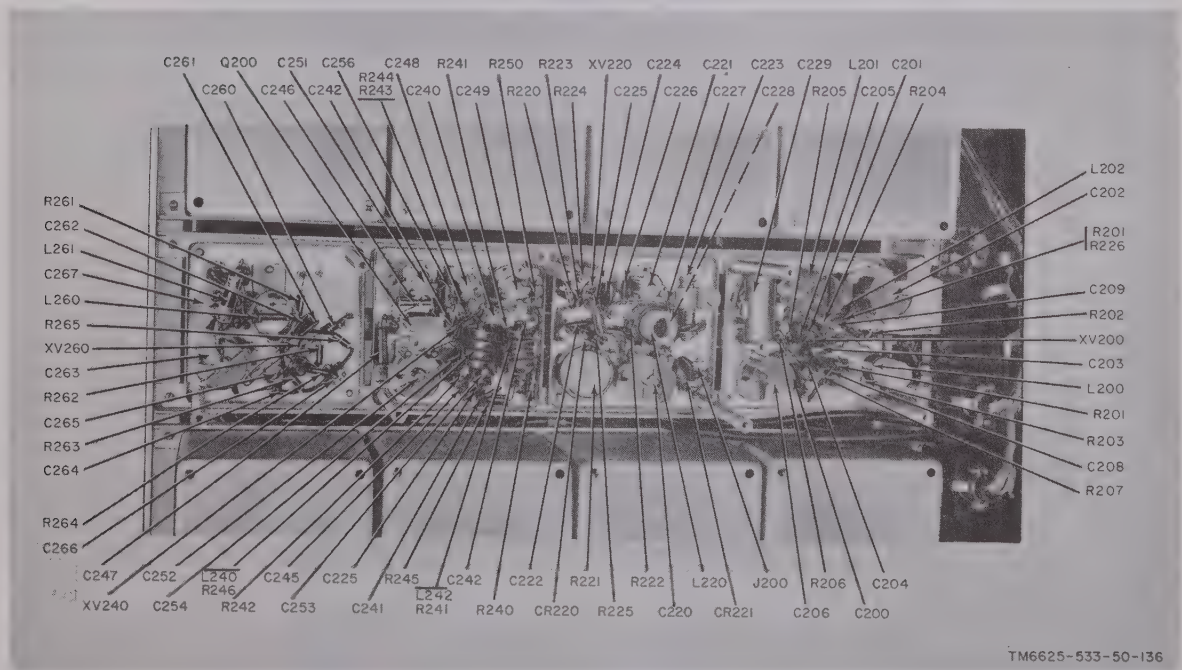


Figure 2–17. Frequency Multiplier CV–1518/URM–18A, rear view with 10–mc shield cans removed.

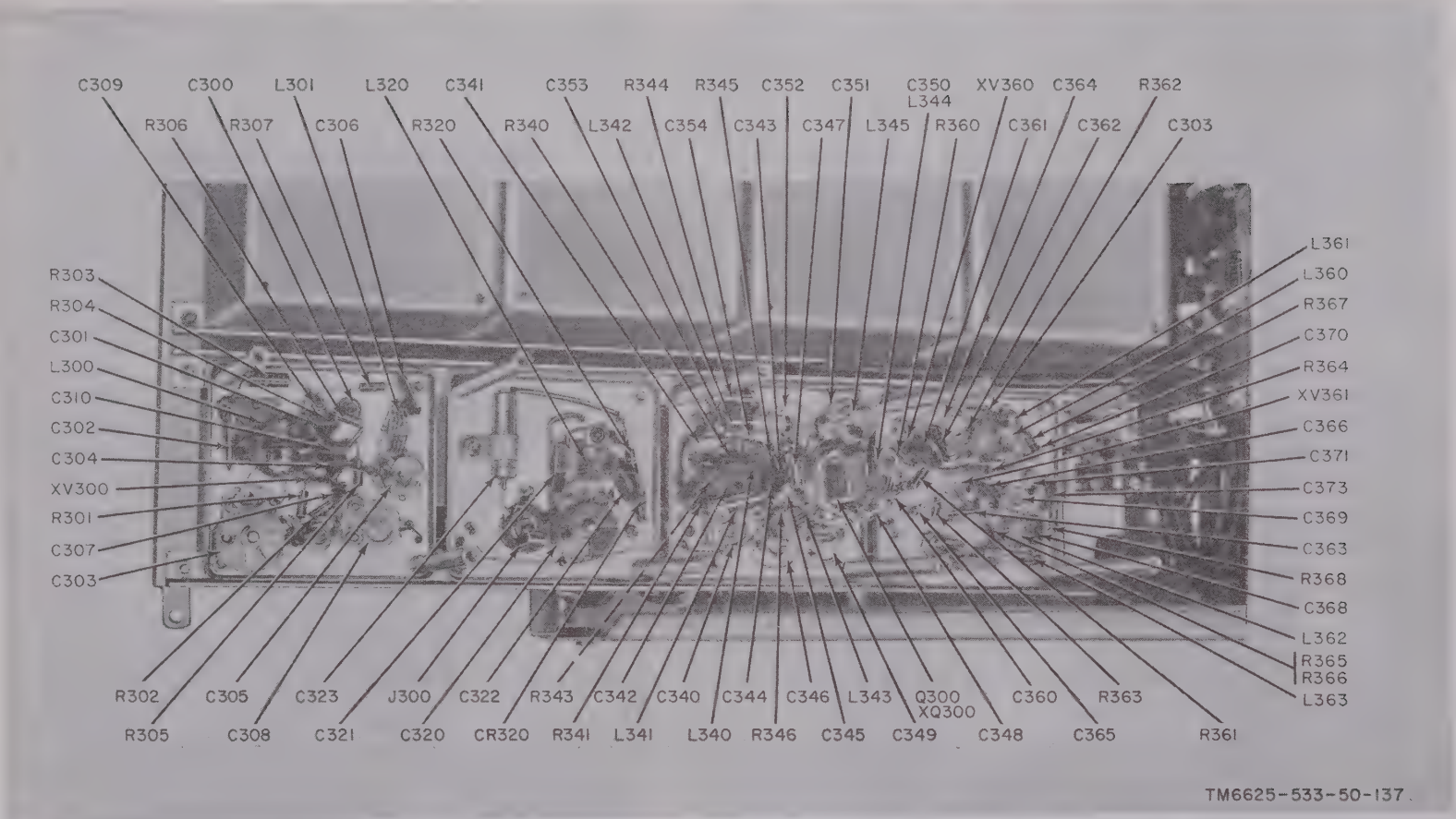


Figure 2–18. Frequency Multiplier CV–1518/URM–18A, rear interior view with 100-mc shield cans removed.

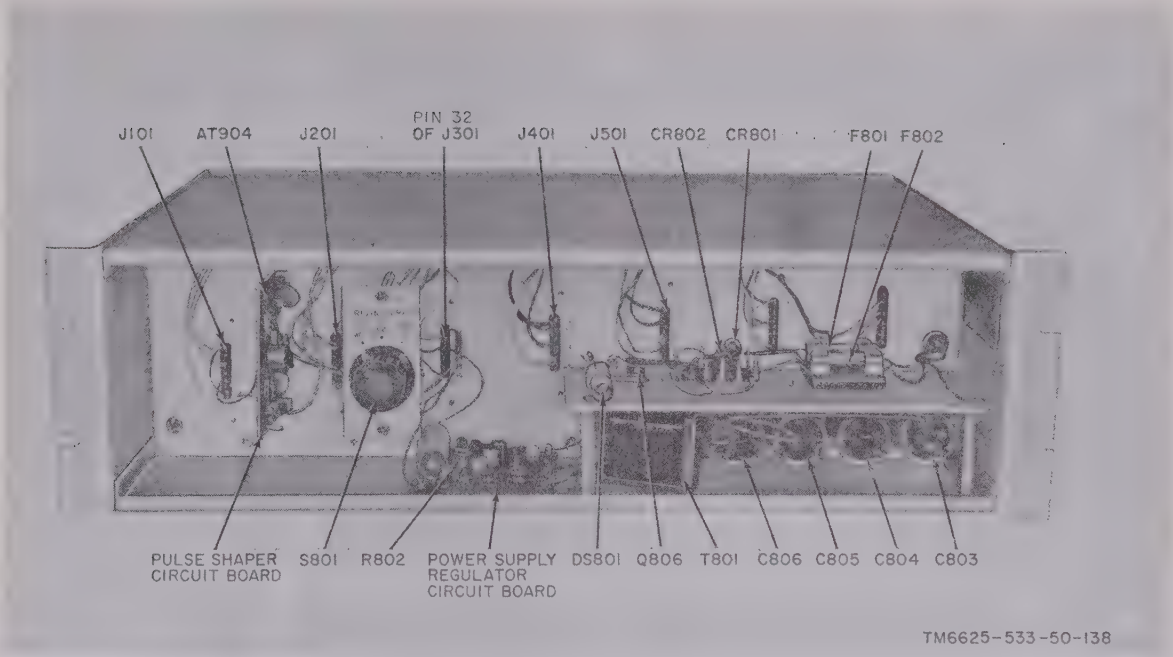


Figure 2–19. Frequency Divider CV–1517/URM–18A, front view with front panel removed.

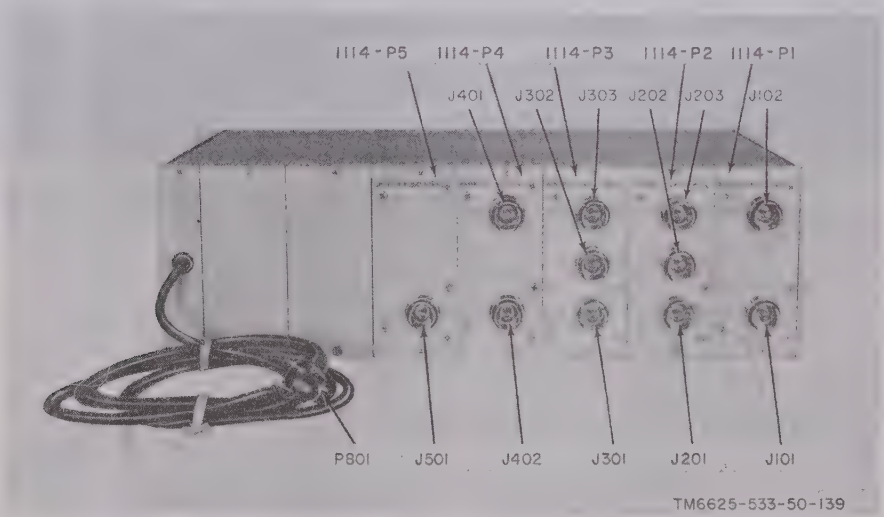


Figure 2–20. Frequency Divider CV–1517/URM–18A, rear view.

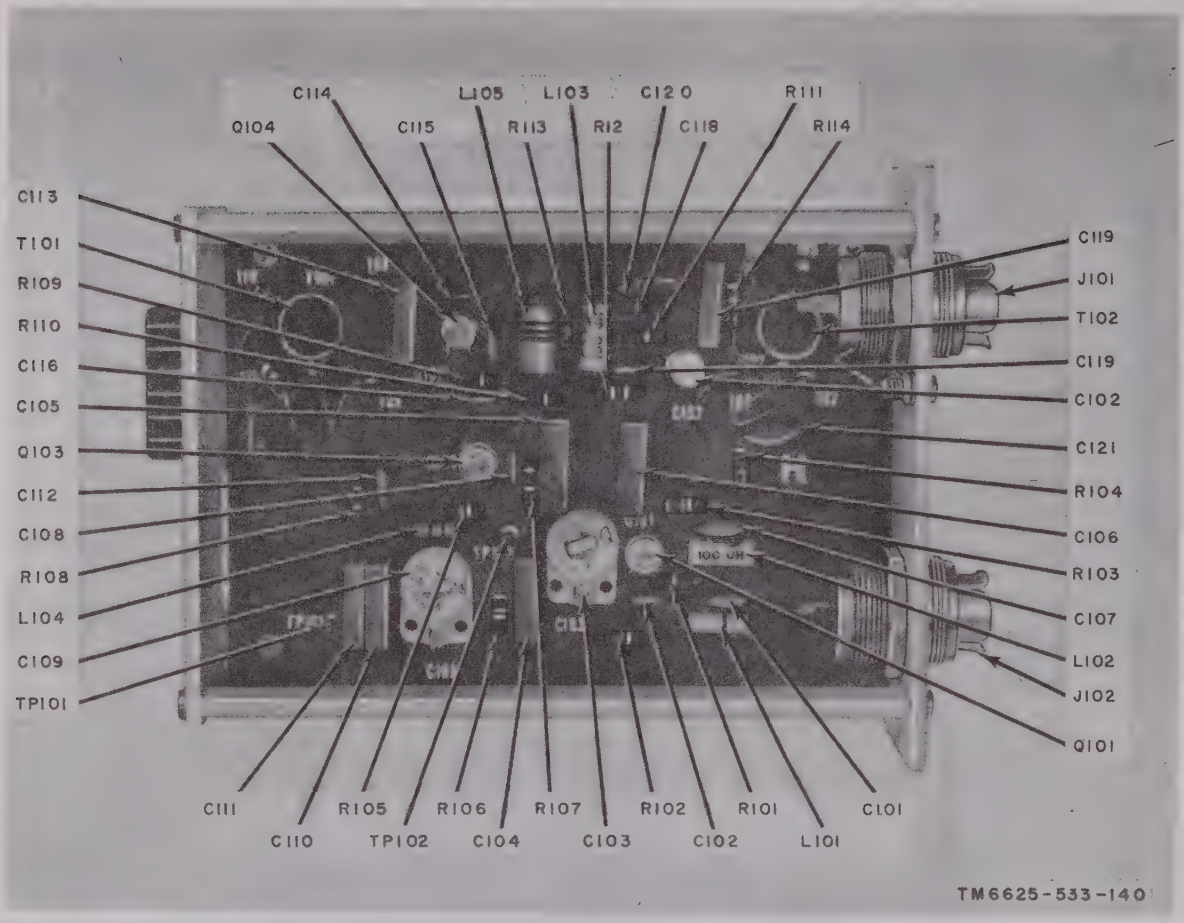


Figure 2–21. Frequency Divider CV–1517/URM–18A, 1114–P1 plug-in unit, side view.

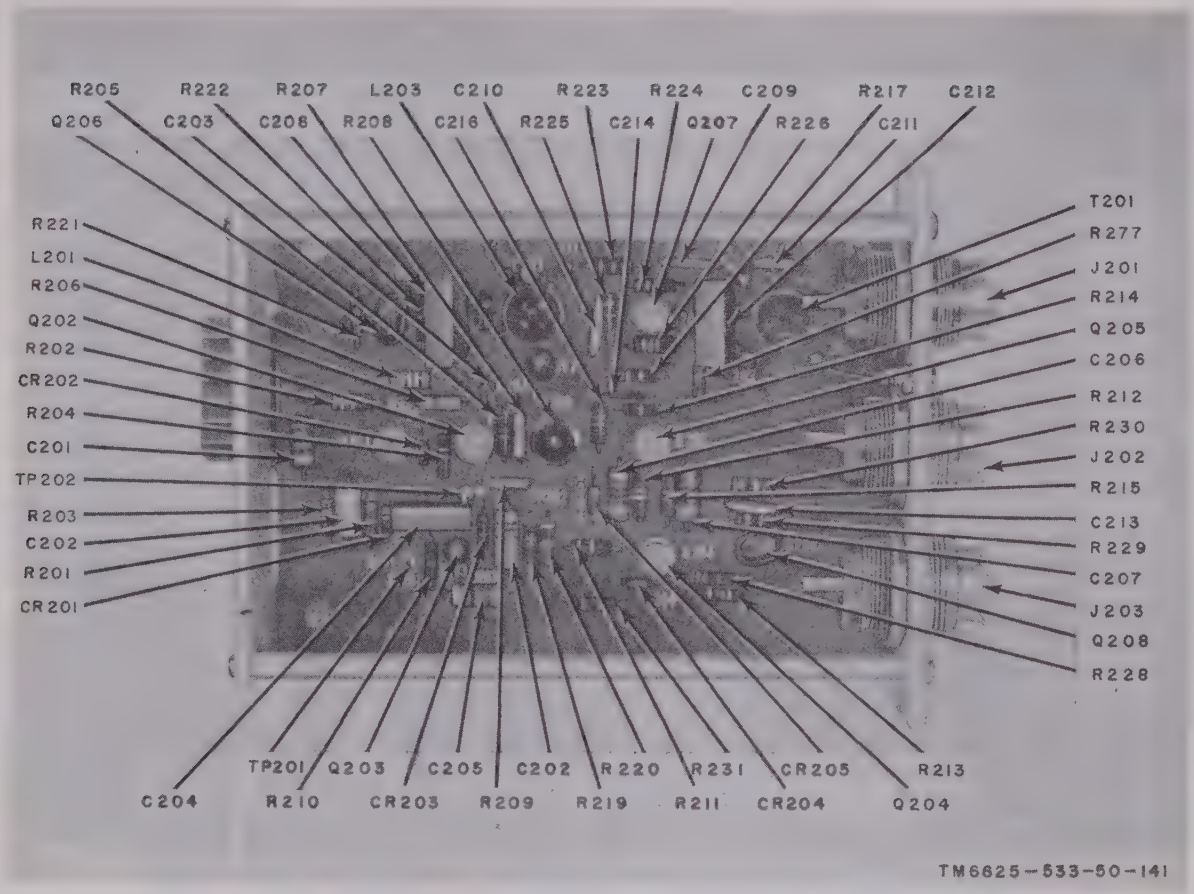


Figure 2–22. Frequency Divider CV–1517/URM–18A, 1114-P2 plug-in unit, side view.

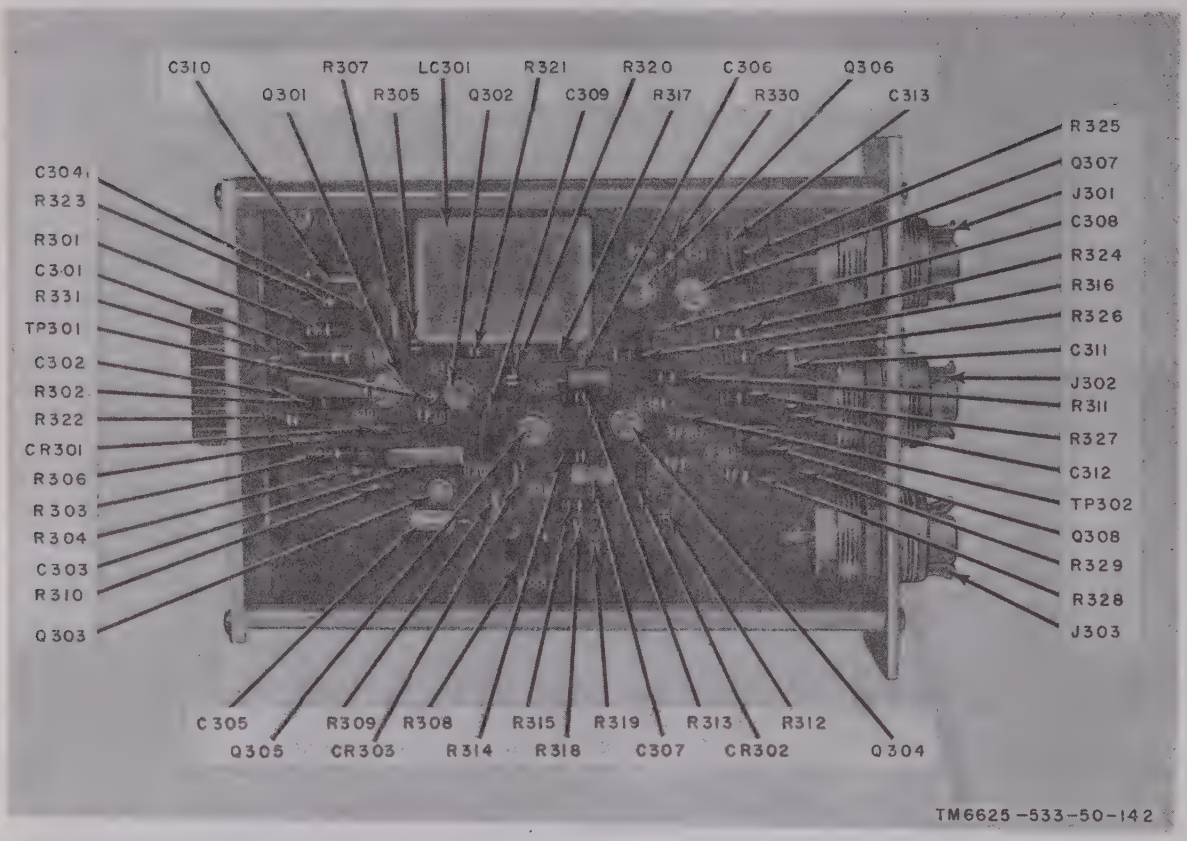


Figure 2–23. Frequency Divider CV–1517/URM–18A, 1114-P4 plug-in unit, side view.

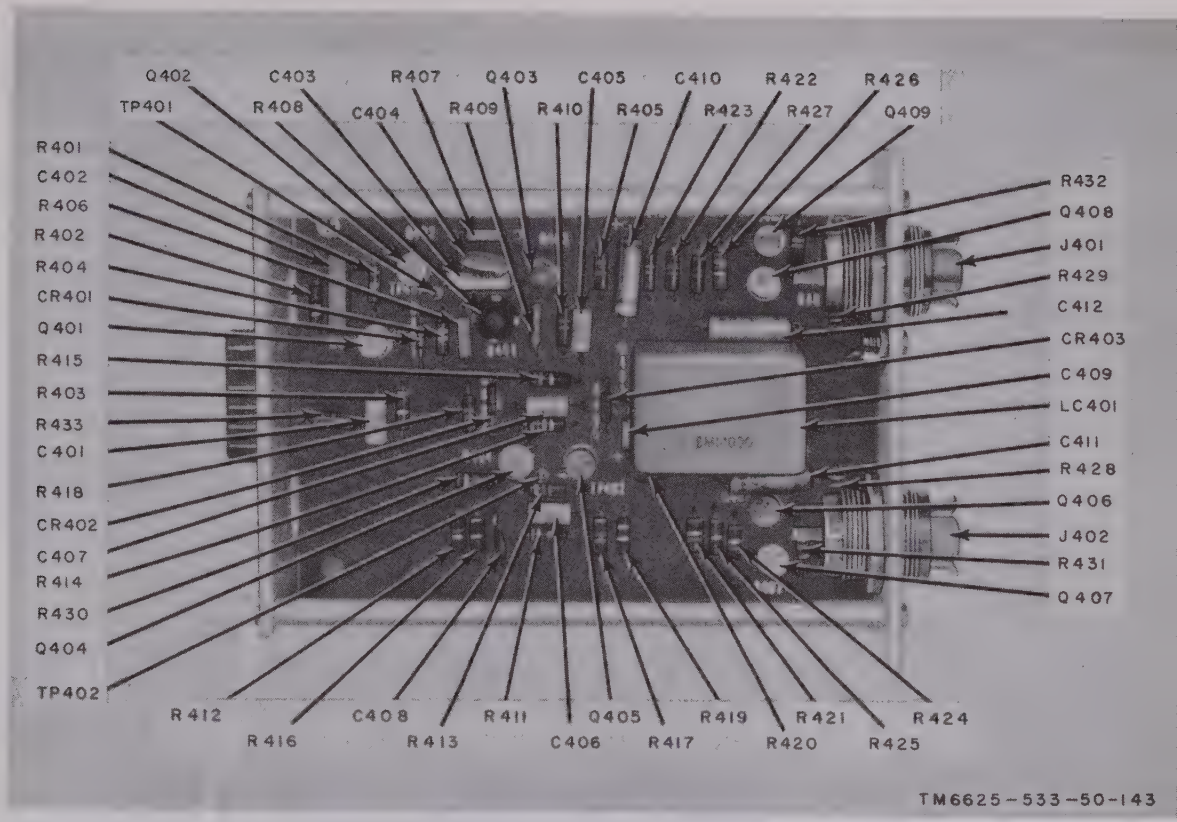


Figure 2–24. Frequency Divider CV–1517/URM–18A, 1114-P4 plug-in unit, side view.

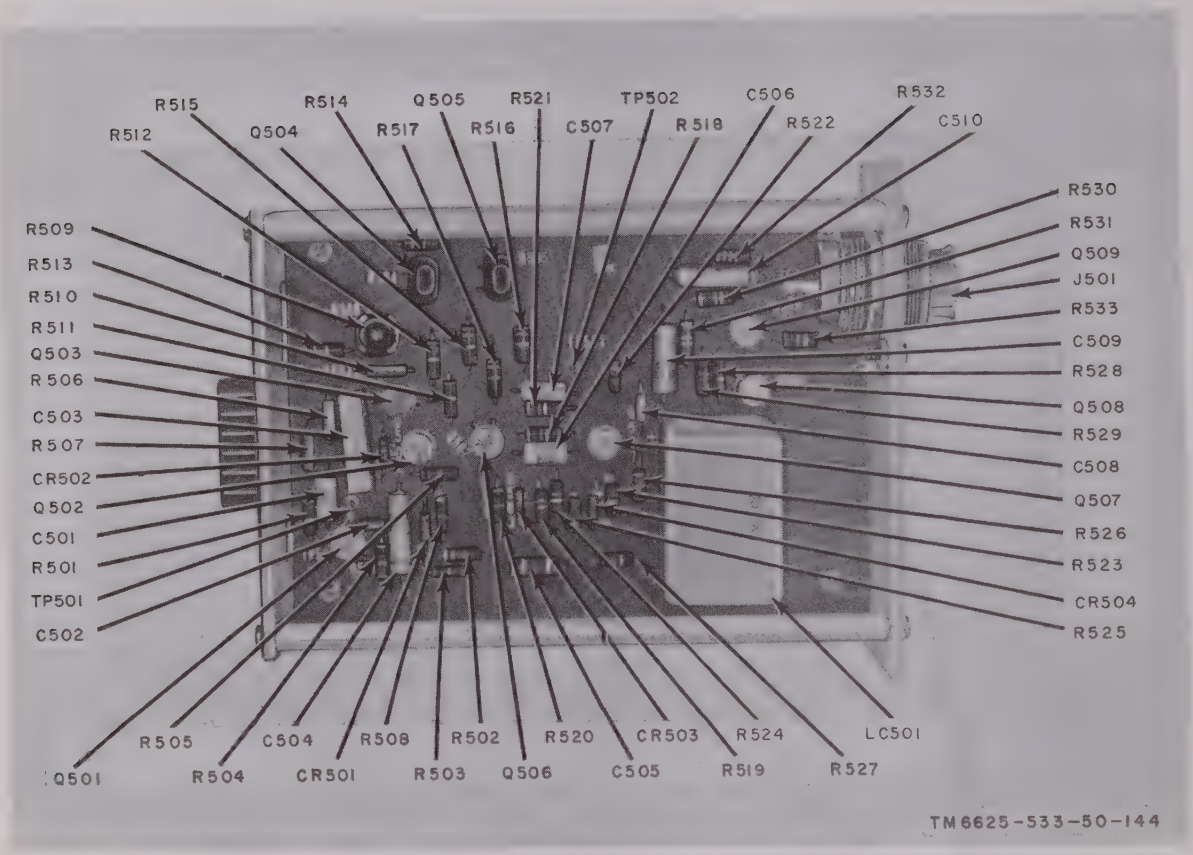


Figure 2–25. Frequency Divider CV–1517/URM–18A, 1114–P5 plug-in unit, side view.

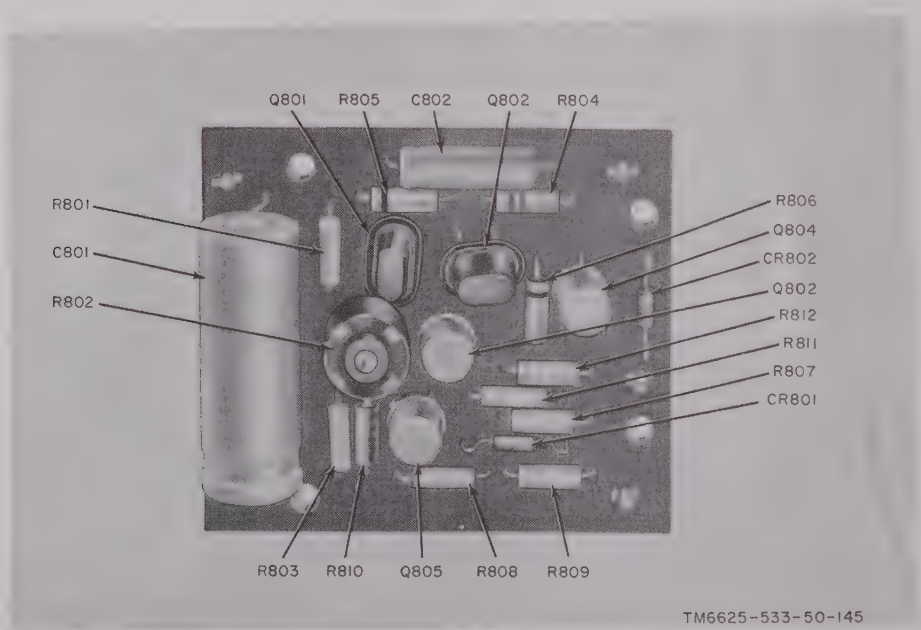


Figure 2–26. Frequency Divider CV–1517/URM–18A, power supply regulator board.

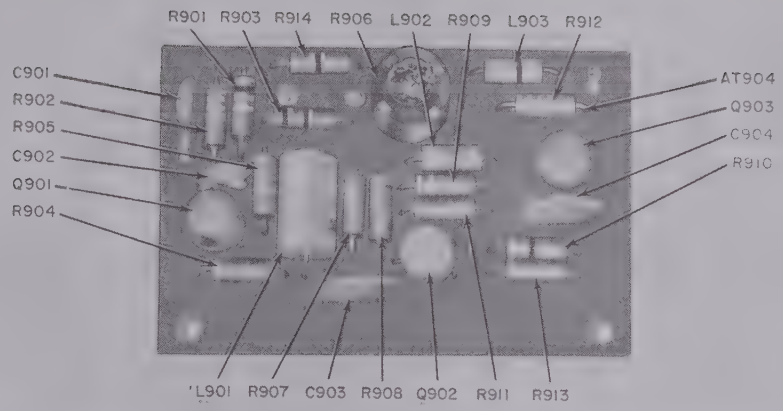


Figure 2–27. Frequency Divider CV–1517/URM–18A, pulse shaper circuit board.

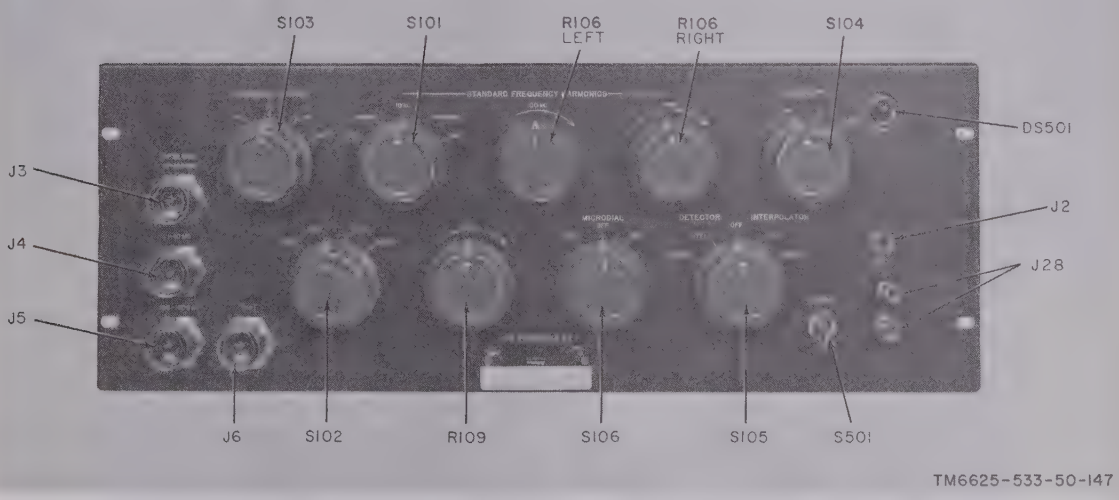


Figure 2–28. Panel, Control SB–105A/URM–18, front view.

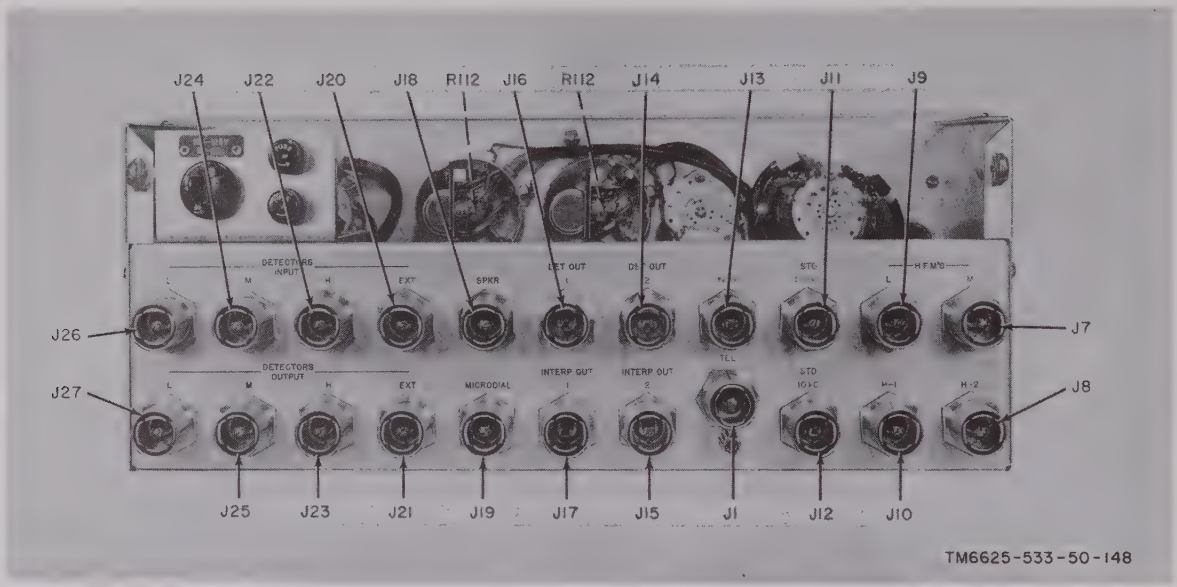


Figure 2-29. Panel, Control SB-105A/URM-18, rear view.

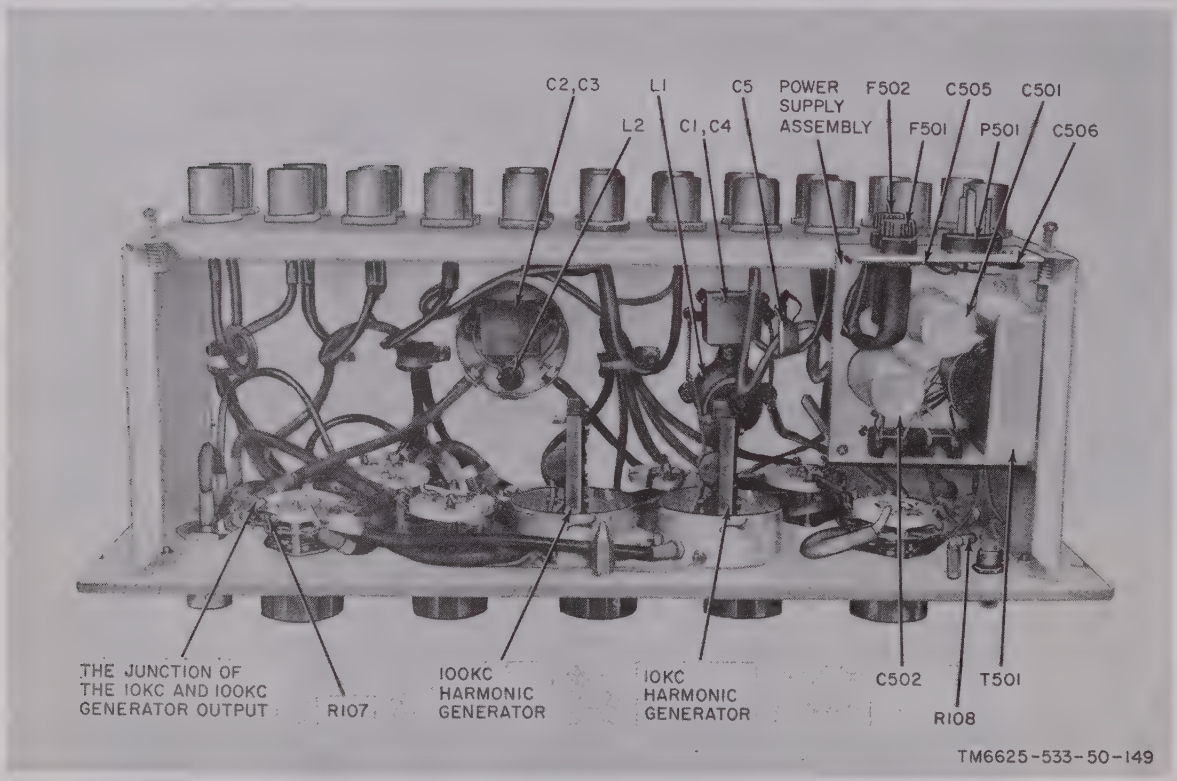


Figure 2-30. Panel, Control SB-105A/URM-18, top interior view.

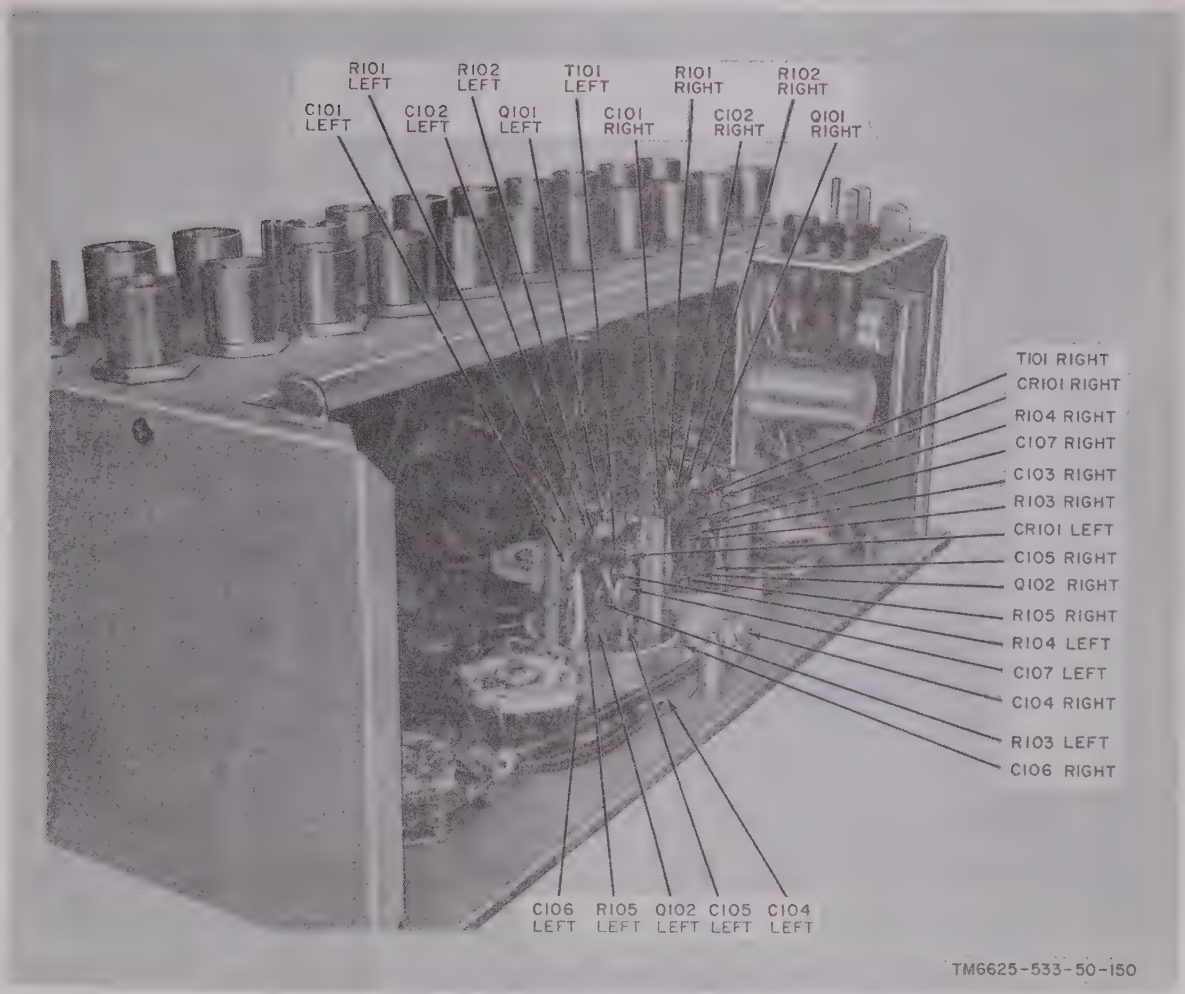


Figure 2–31. Panel, Control SB–105A/URM–18, close-up interior view.

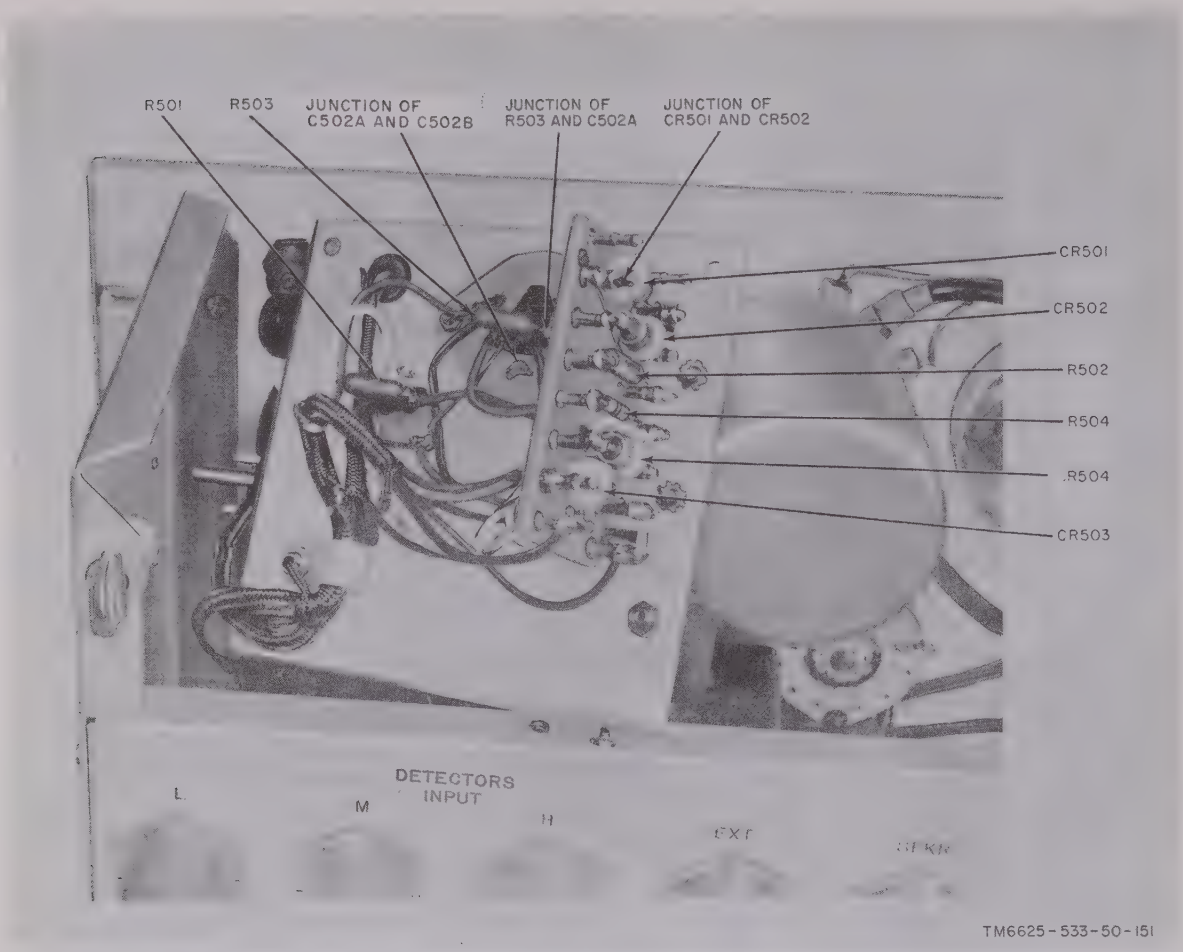


Figure 2–32. Panel, Control SB–105A/URM–18, rear view of power supply.

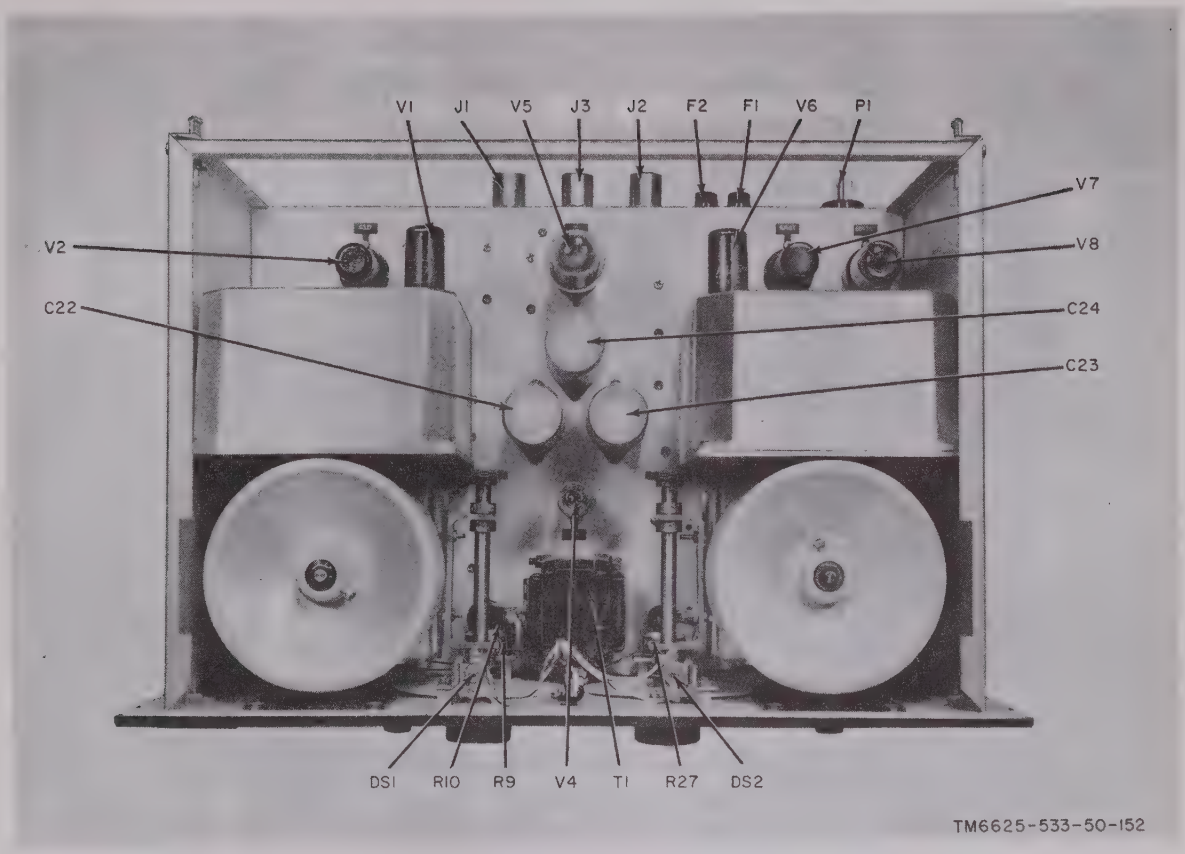


Figure 2–33. Frequency Meters FR–43/URM–18 and FR–44/URM–18, top interior view.

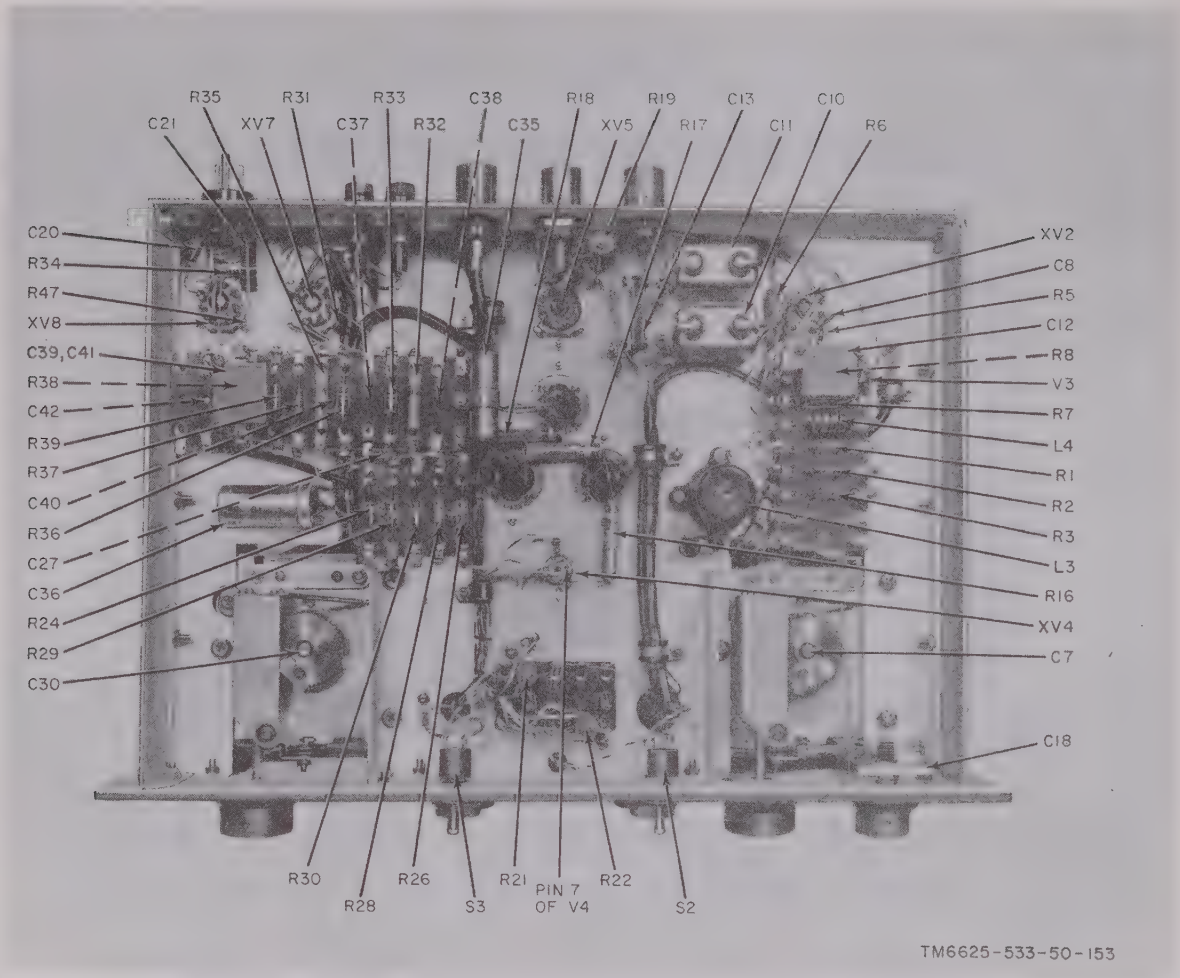


Figure 2–34. Frequency Meter FR–43A/URM–18, bottom view.

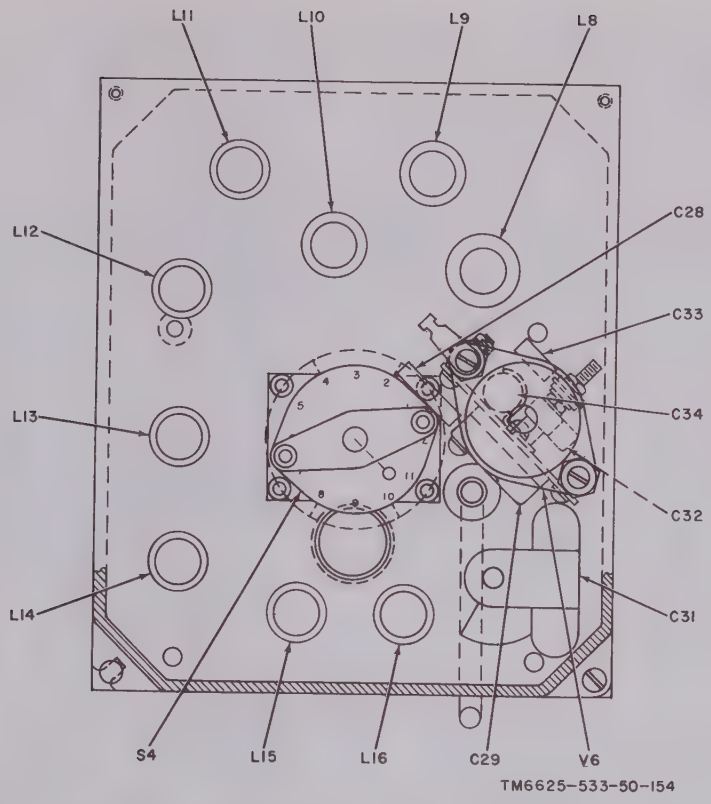


Figure 2–35. Frequency Meter FR–43A/URM–18, frequency meter coil selector unit.

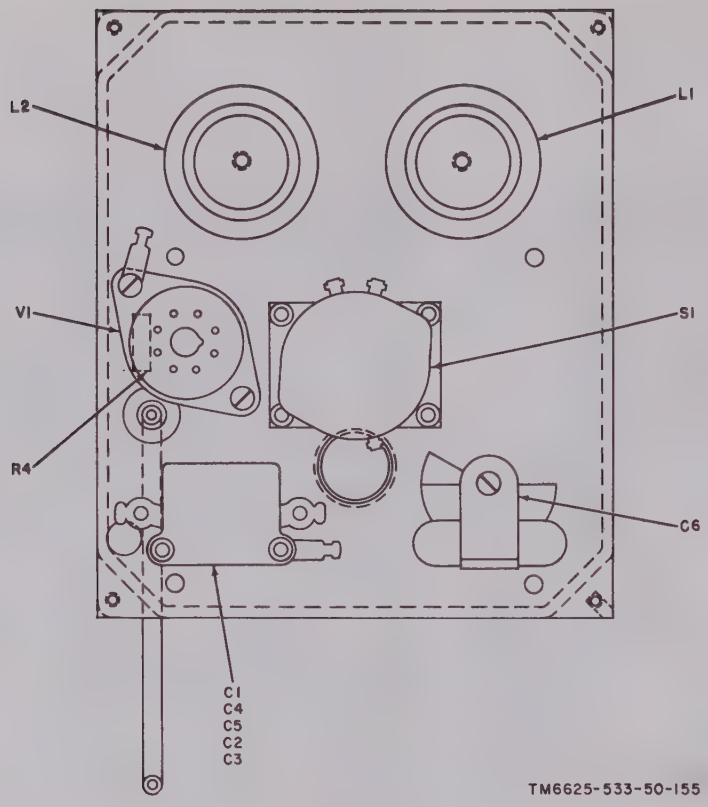


Figure 2–36. Frequency Meter FR–43A/URM–18, detector coil selector unit.

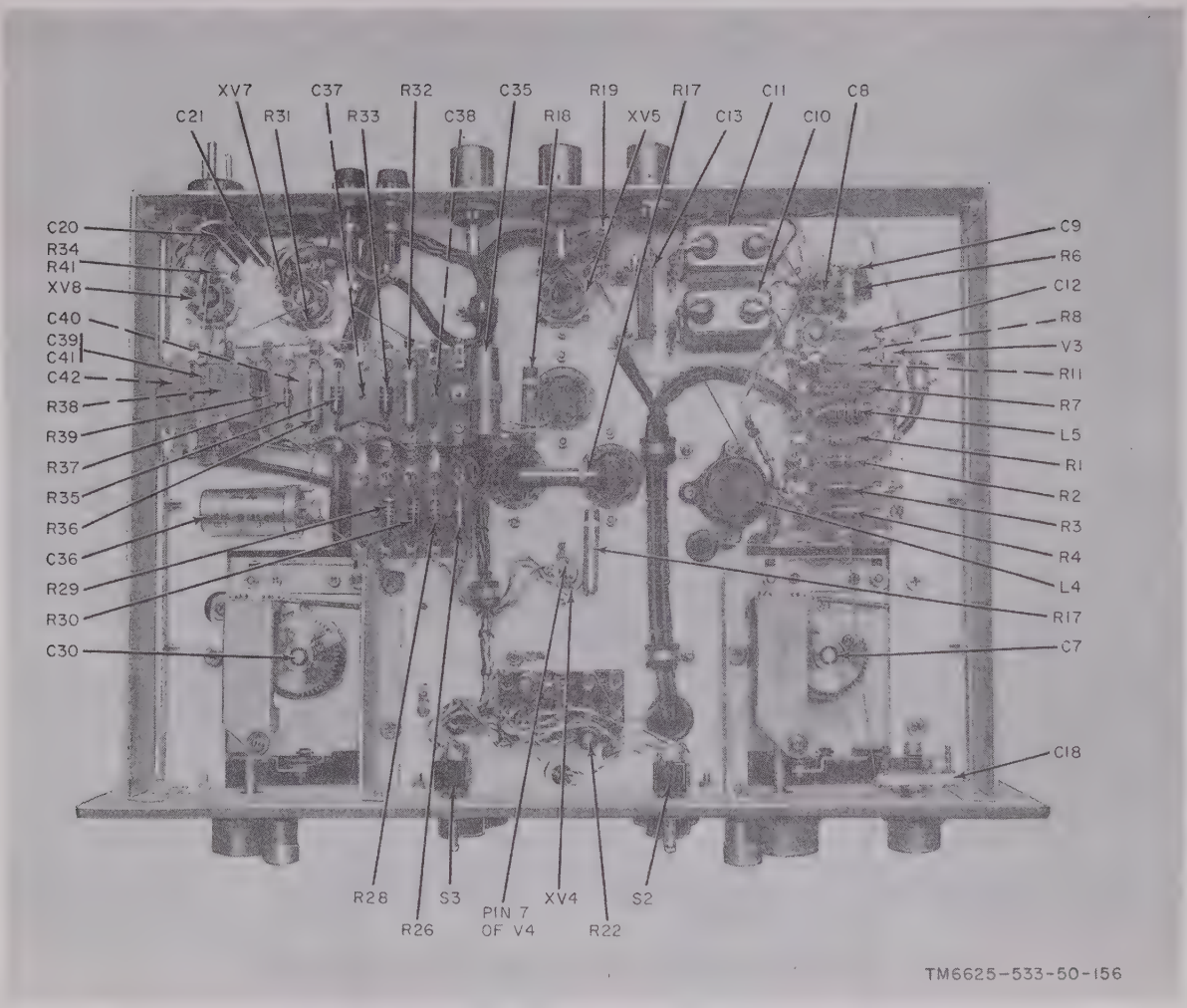


Figure 2–37. Frequency Meter FR–44/URM–18, bottom view.

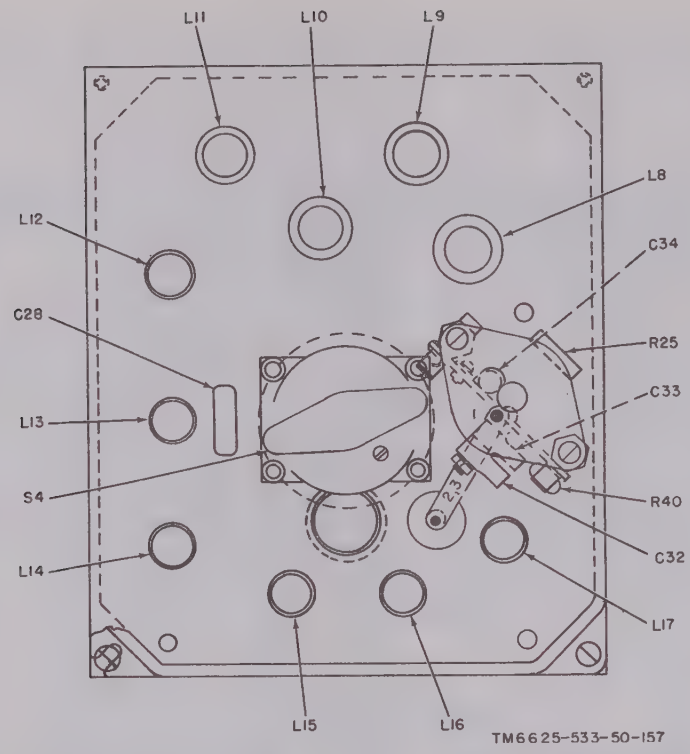


Figure 2–38. Frequency Meter FR–44/URM–18, frequency meter coil selector unit.

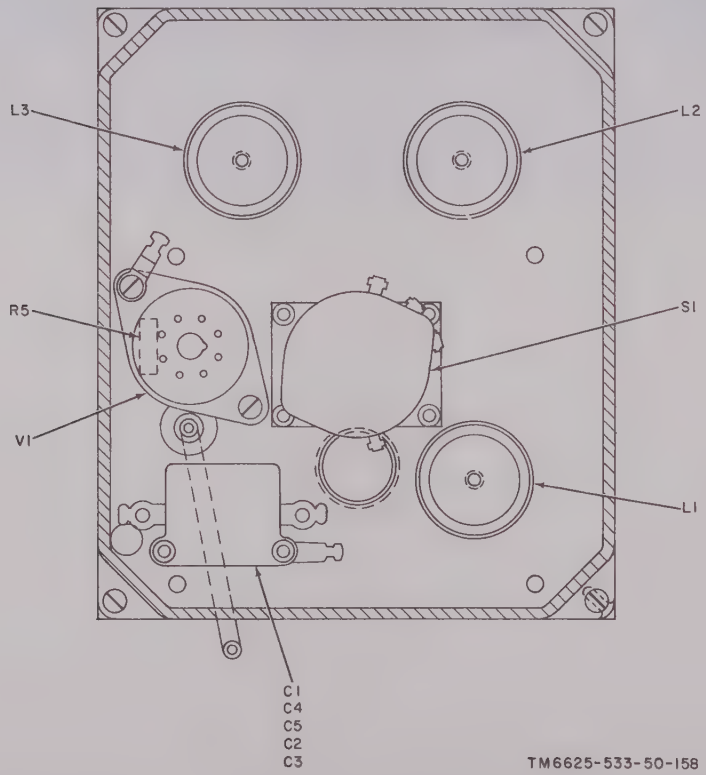


Figure 2–39. Frequency Meter FR–44/URM–18, detector coil selector unit.

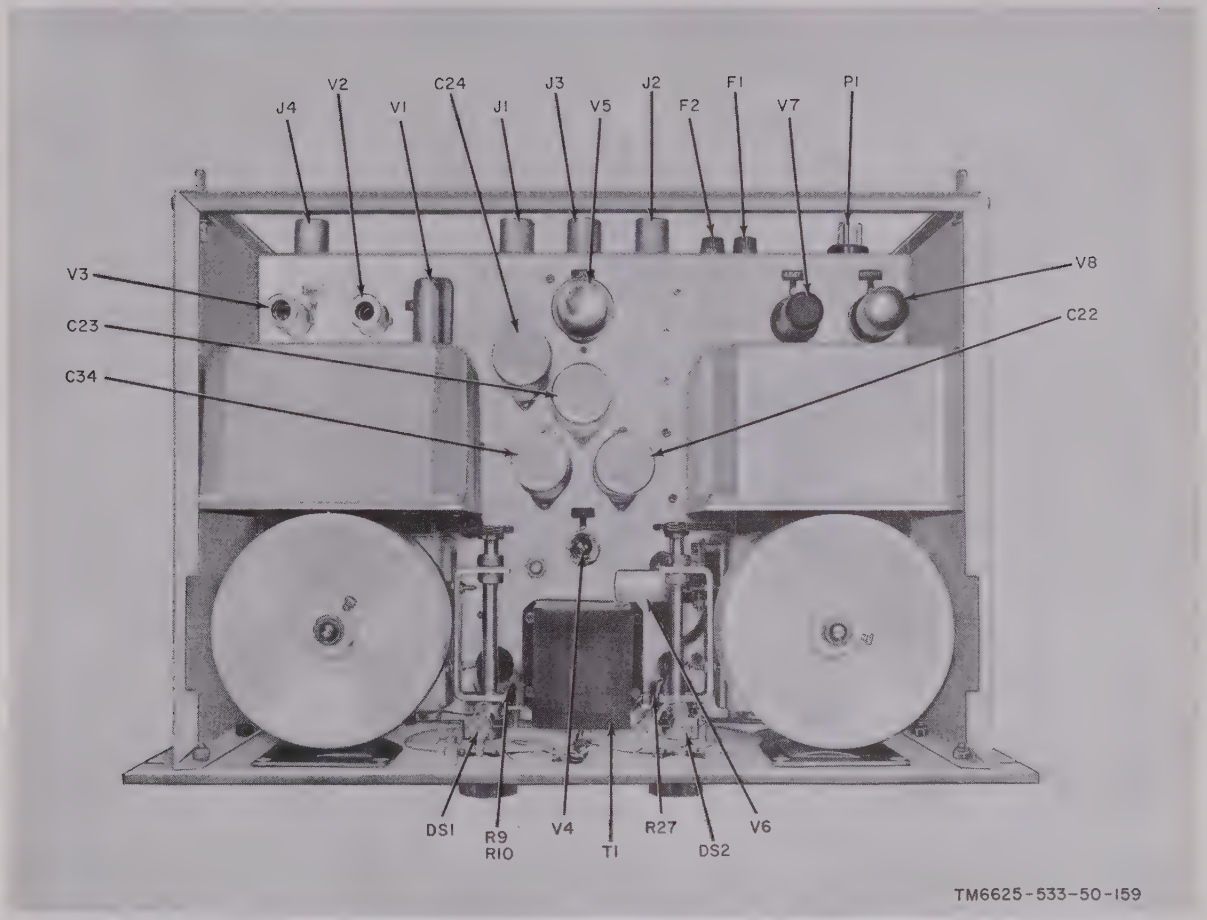


Figure 2–40. Frequency Meter FR–45A/URM–18, top interior view.

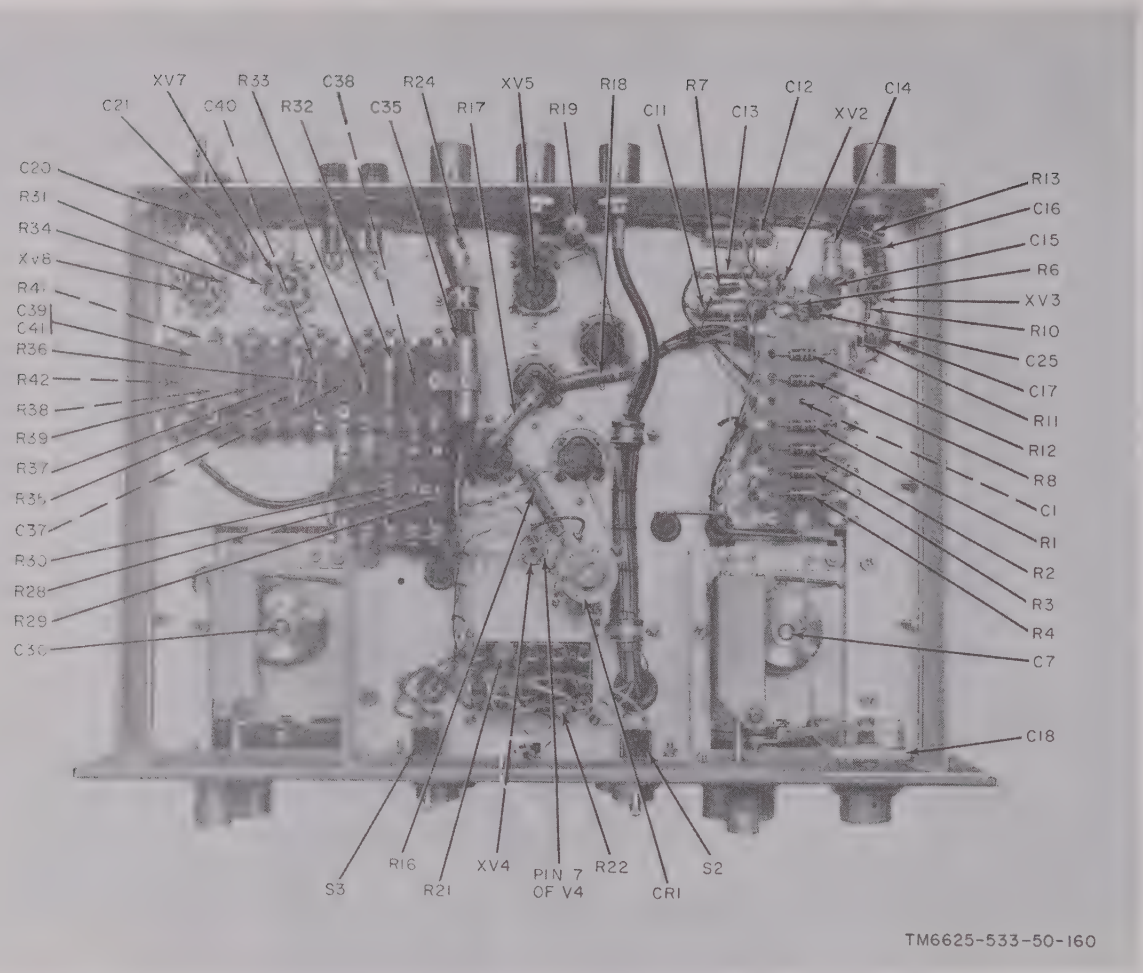


Figure 2–41. Frequency Meter FR–45A/URM–18, bottom view.

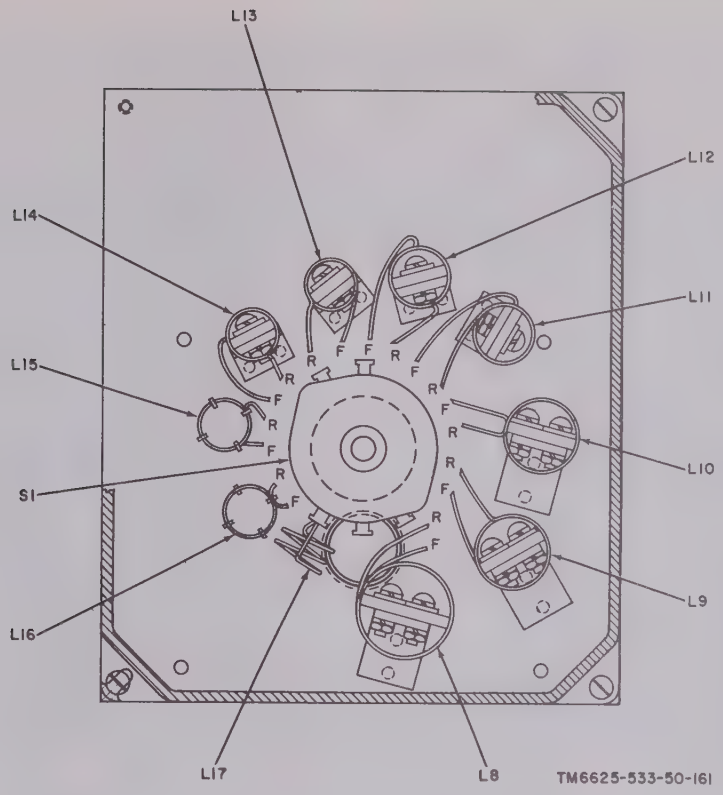


Figure 2–42. Frequency Meter FR–45A/URM–18, frequency meter coil selector unit.

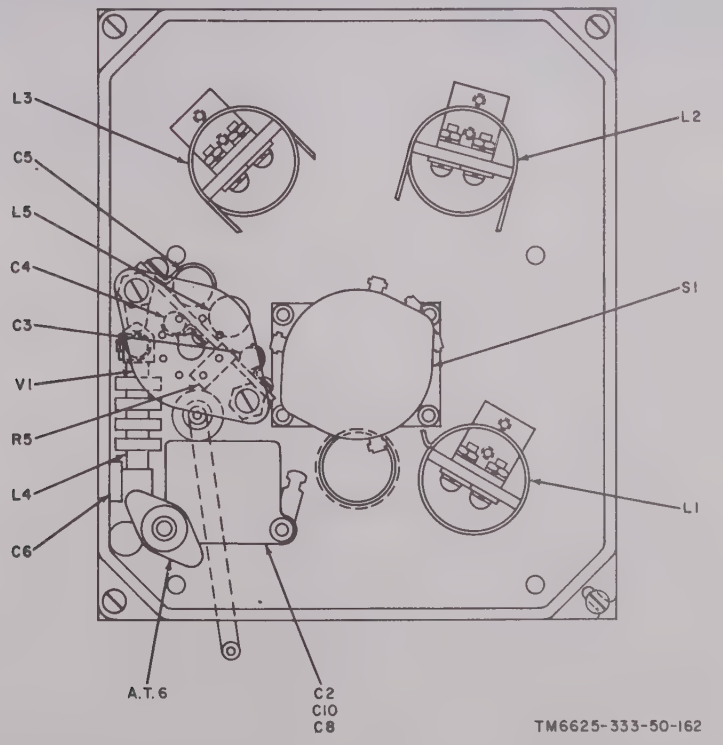


Figure 2–43. Frequency Meter FR–45A/URM–18, detector coil selector unit.

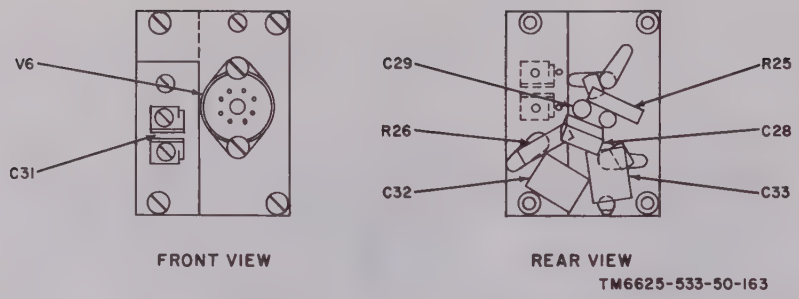


Figure 2–44. Frequency Meter FR–45A/URM–18, tube mounting plate assembly.

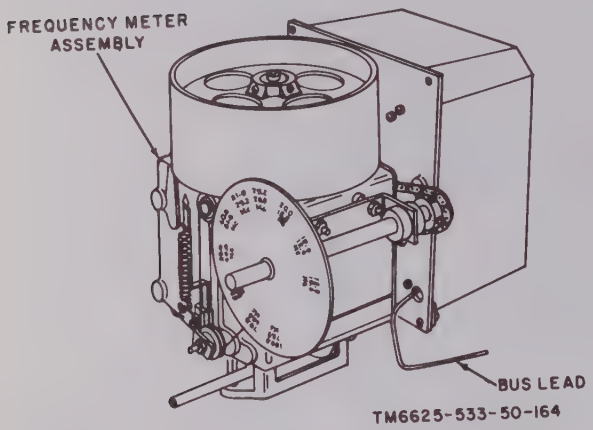


Figure 2–45. Frequency Meters FR–43A/URM–18, FR–44/URM–18, and FR–45A/URM–18, frequency meter assembly

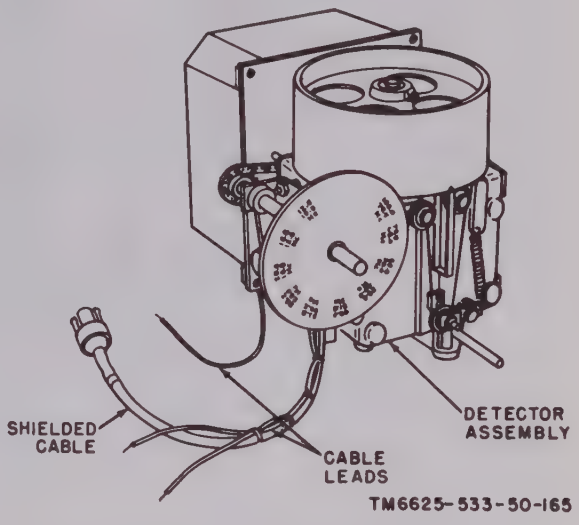


Figure 2–46. Frequency Meters FR–43A/URM–18, FR–44/URM–18, and FR–45A/URM–18, detector assembly.

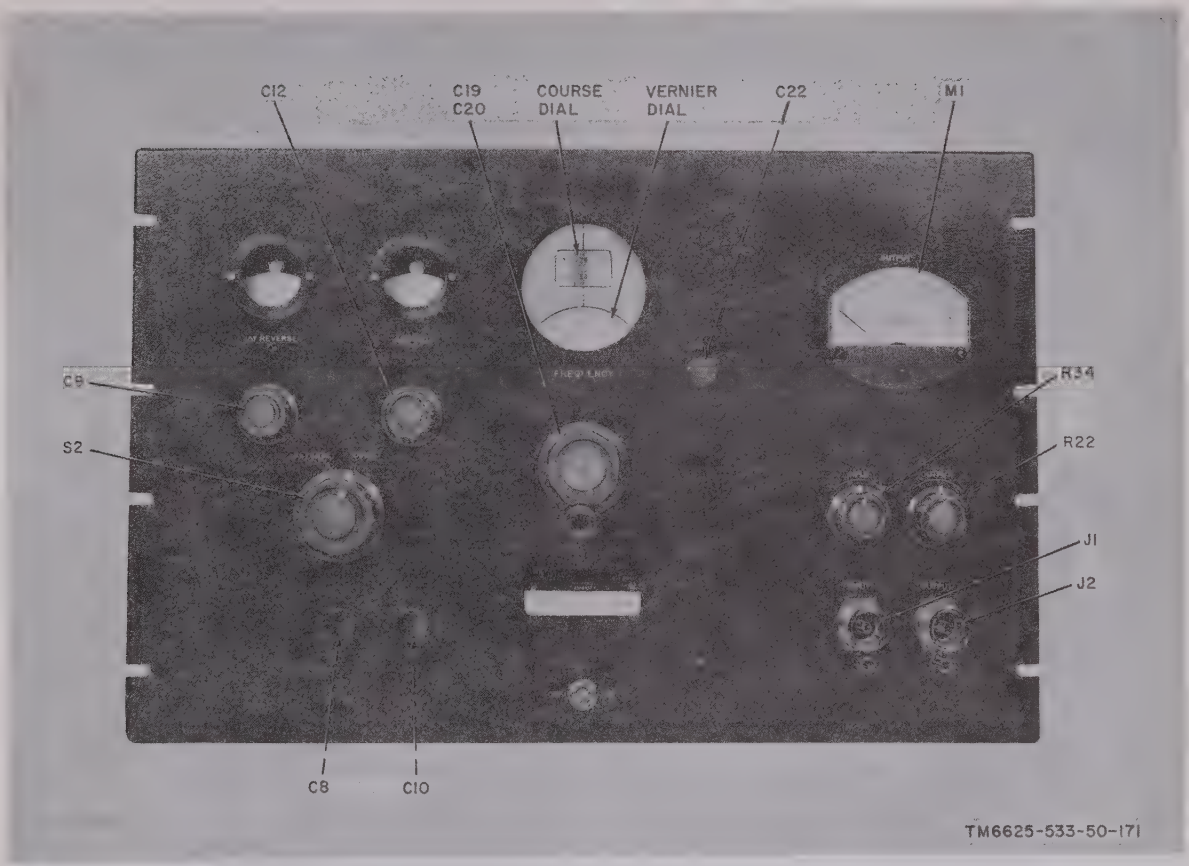


Figure 2–47. Generator, Signal SG–42/URM–18, front view.

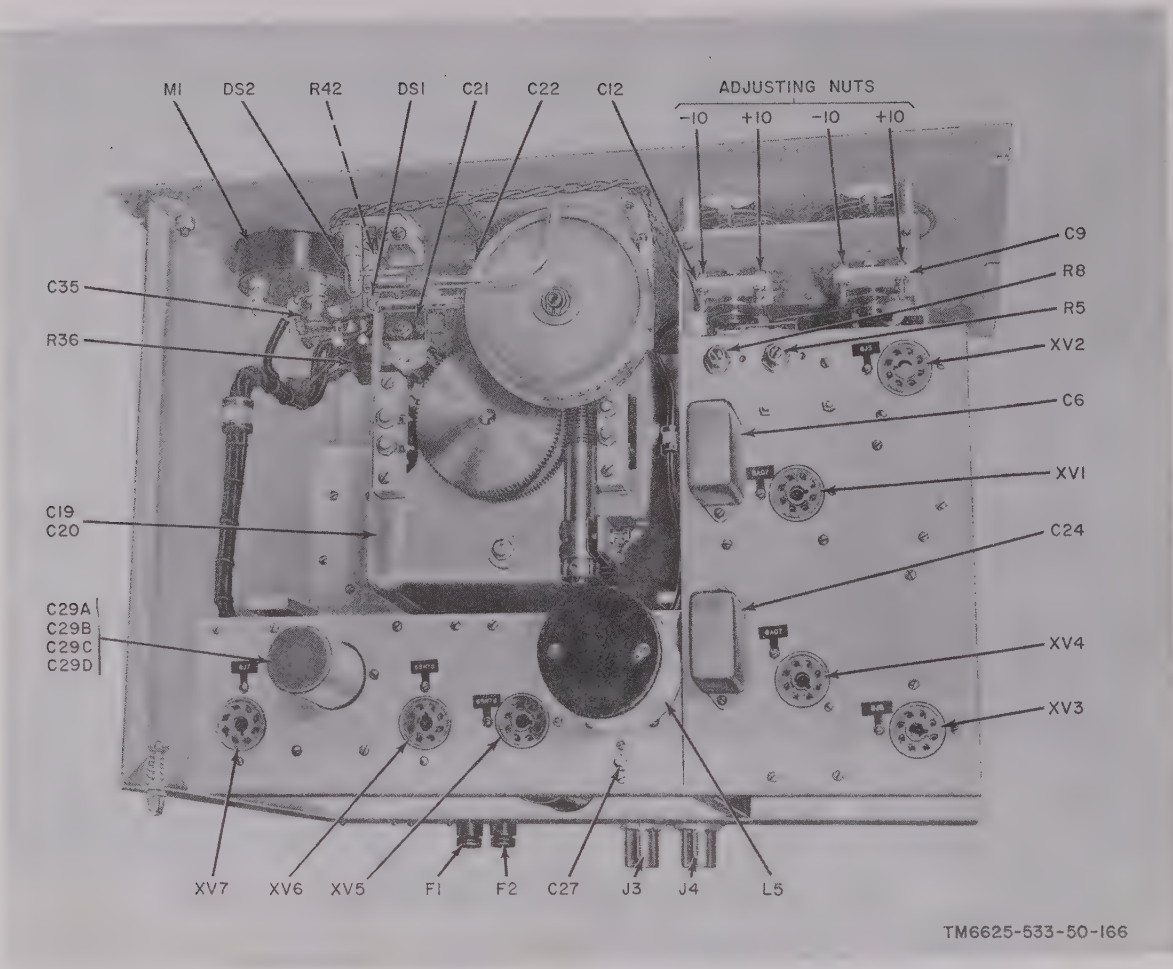


Figure 2–48. Generator, Signal SG–42/URM–18, top view.

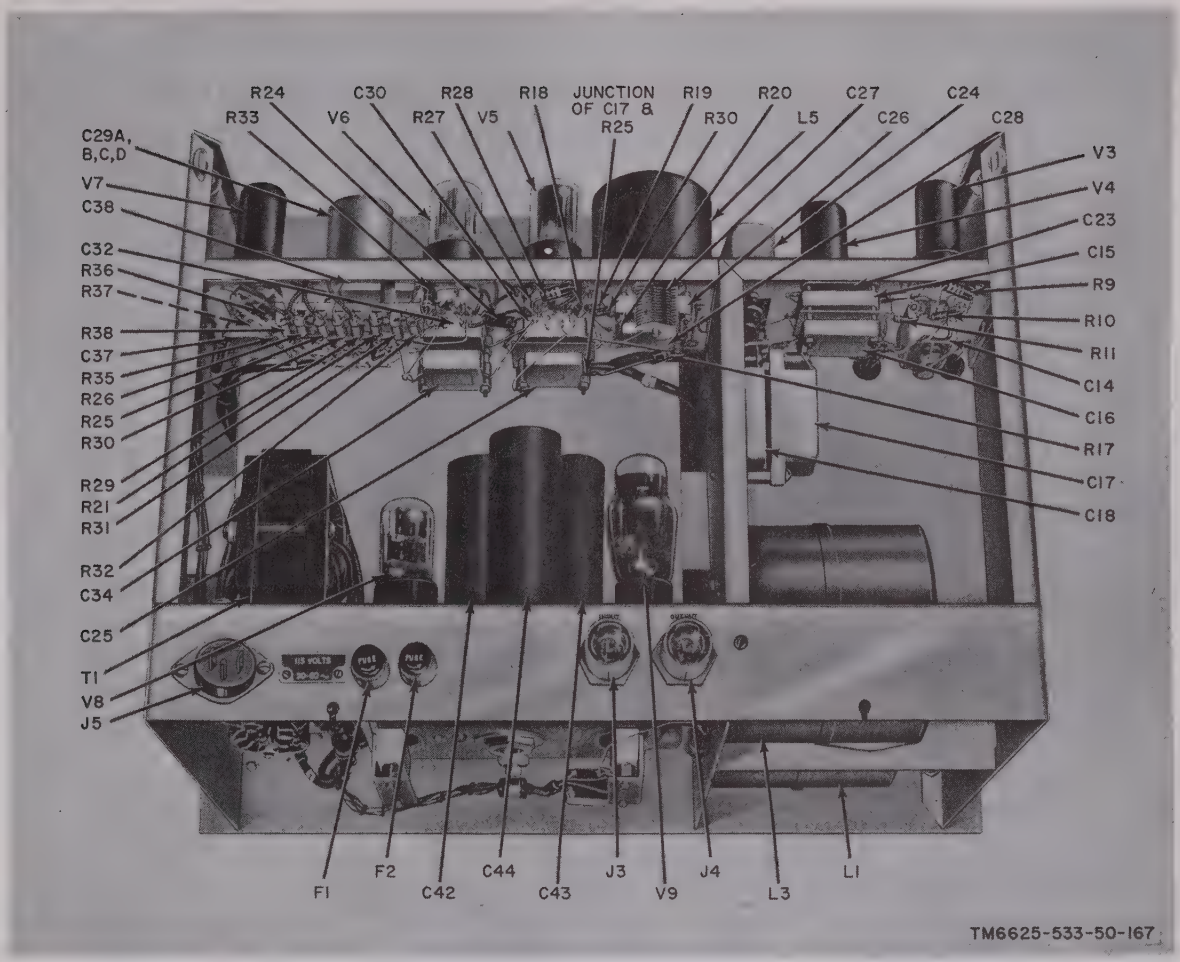


Figure 2–49. Generator, Signal SG–42/URM–18, rear view.

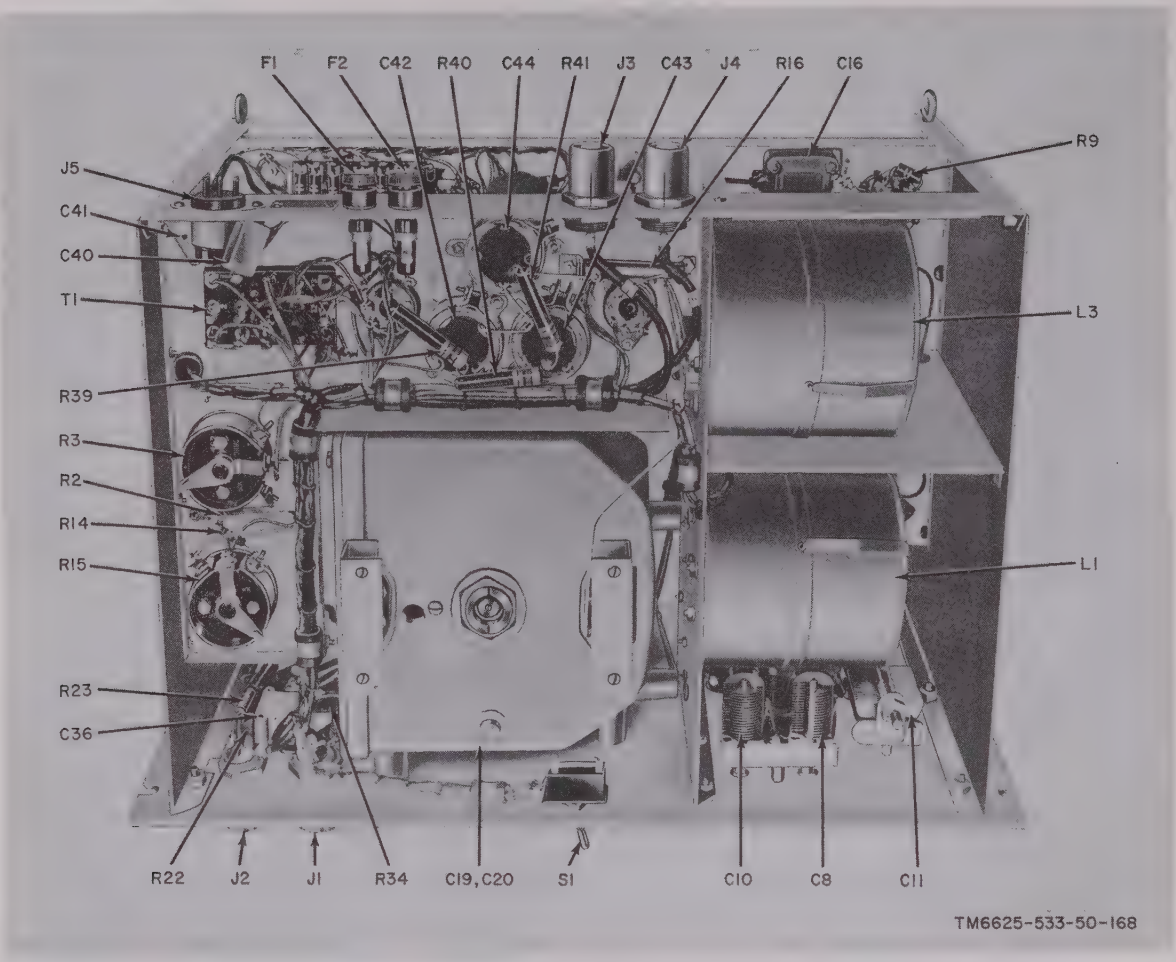


Figure 2–50. Generator, Signal SG–42/URM–18, bottom view.

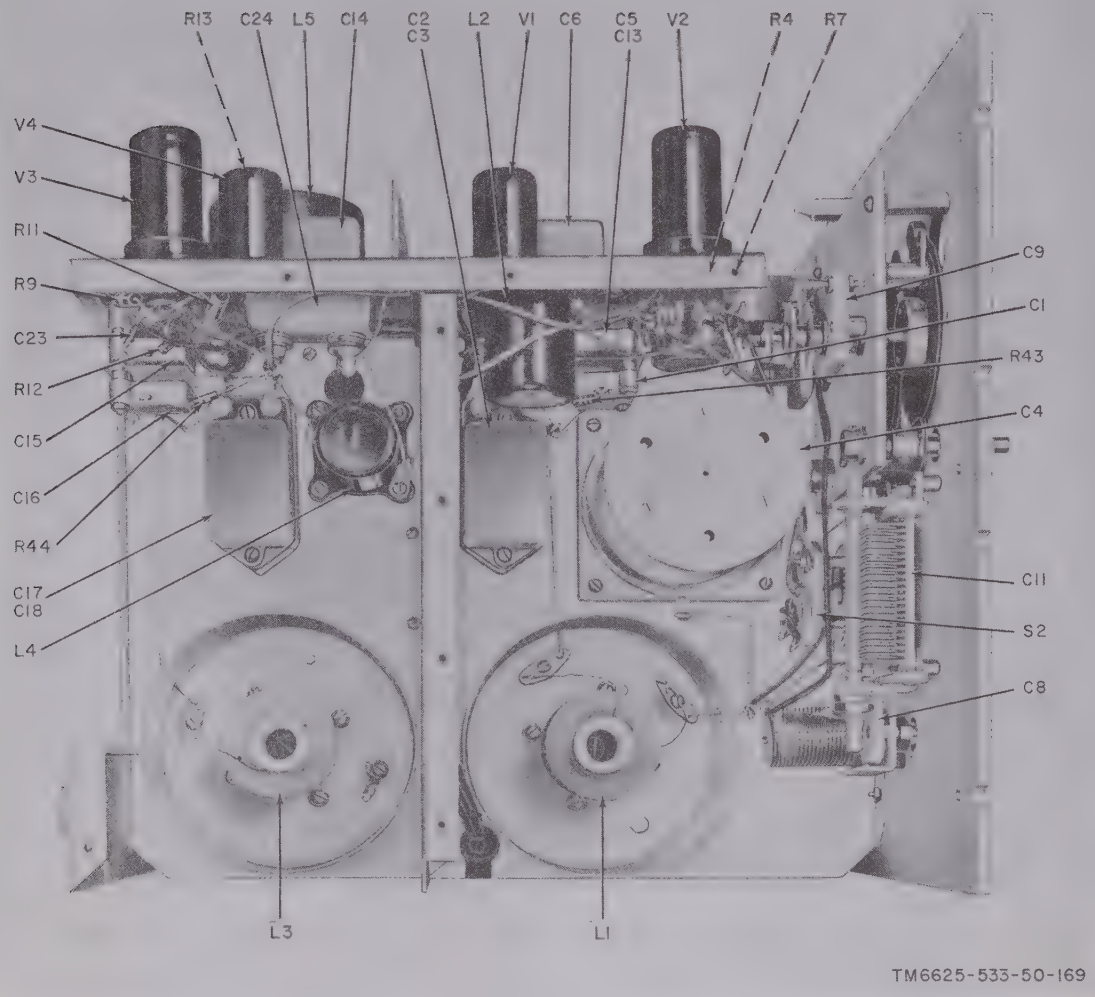


Figure 2–51. Generator, Signal SG–42/URM–18, left side view.

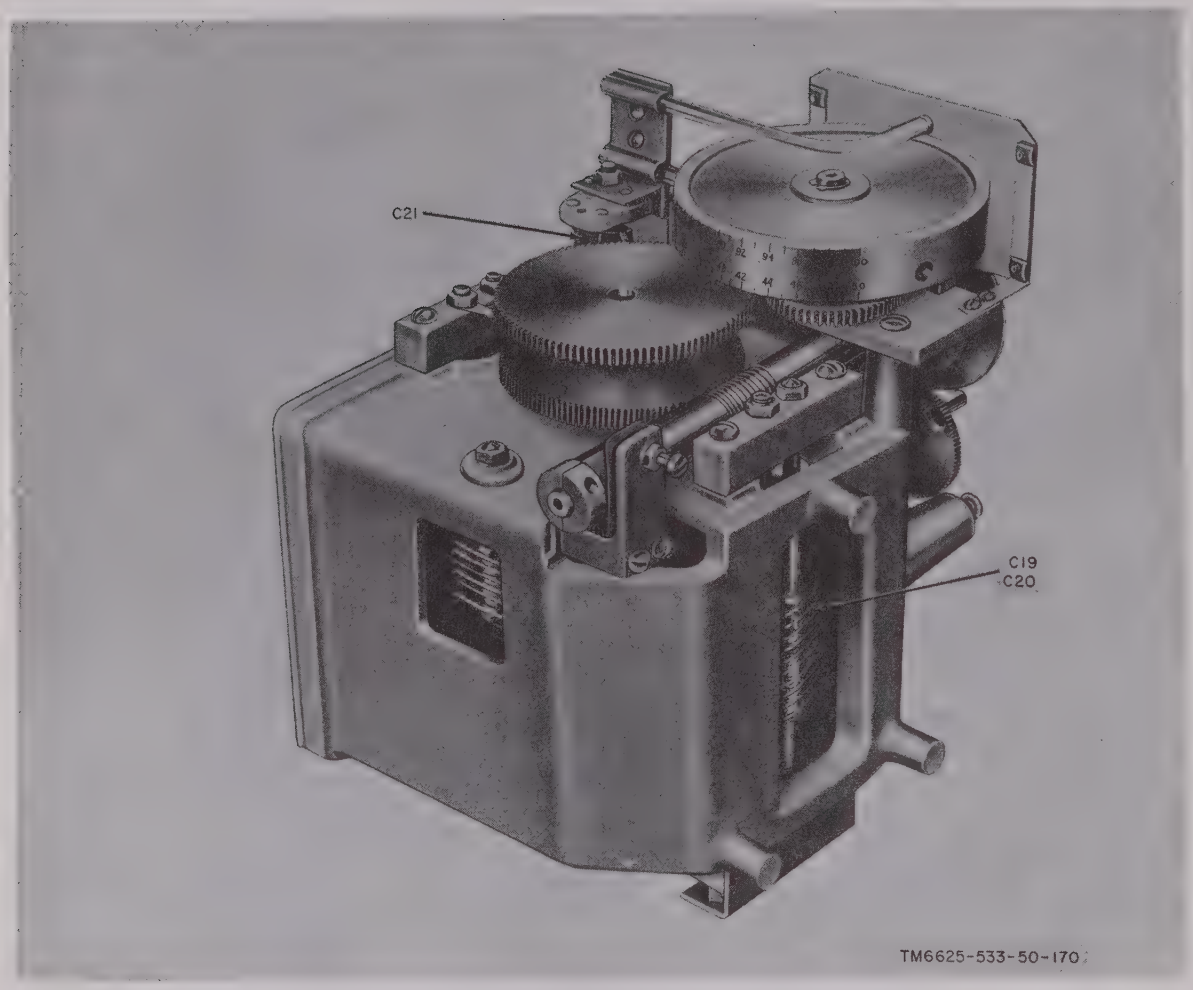


Figure 2–52. Generator, Signal SG–42/URM–18, main tuning capacitor assembly, assembled.

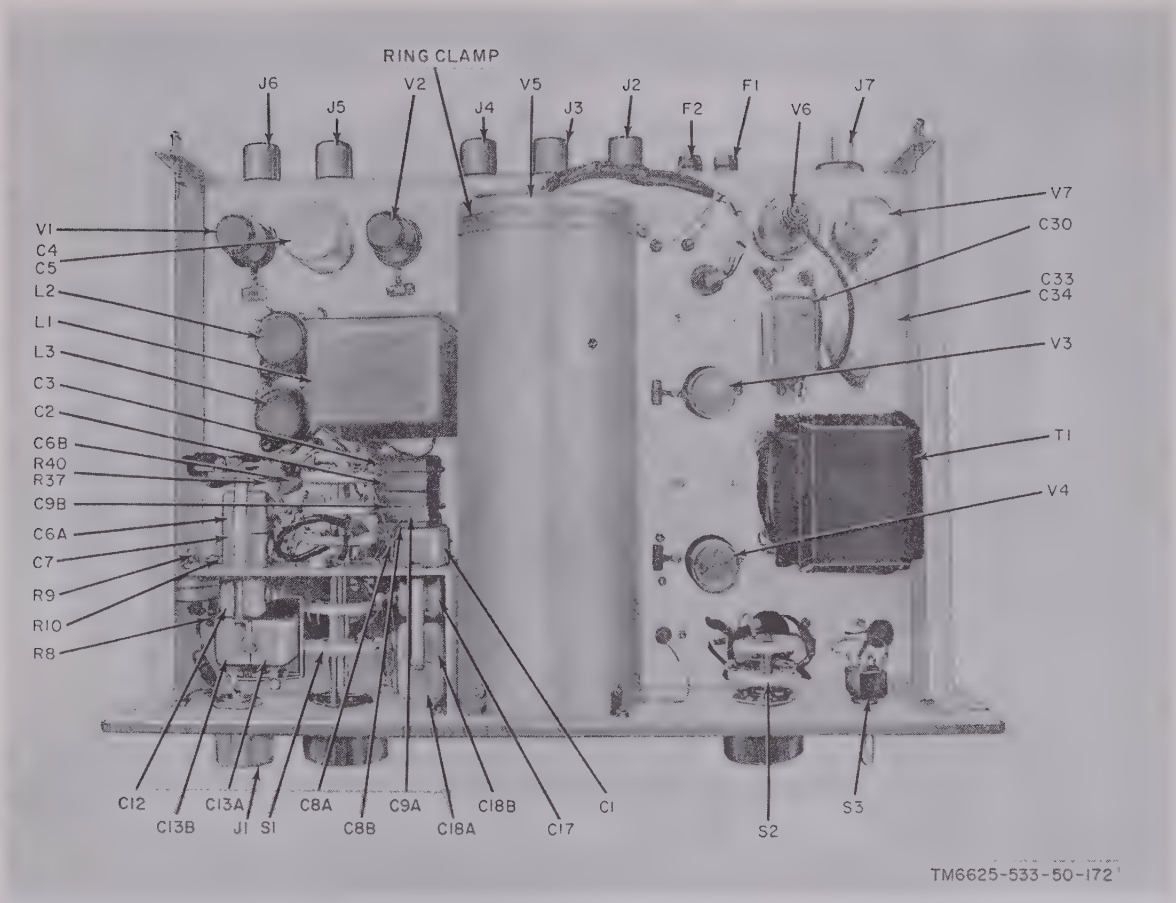


Figure 2–53. Oscilloscope OS–16A/URM–18, top view.

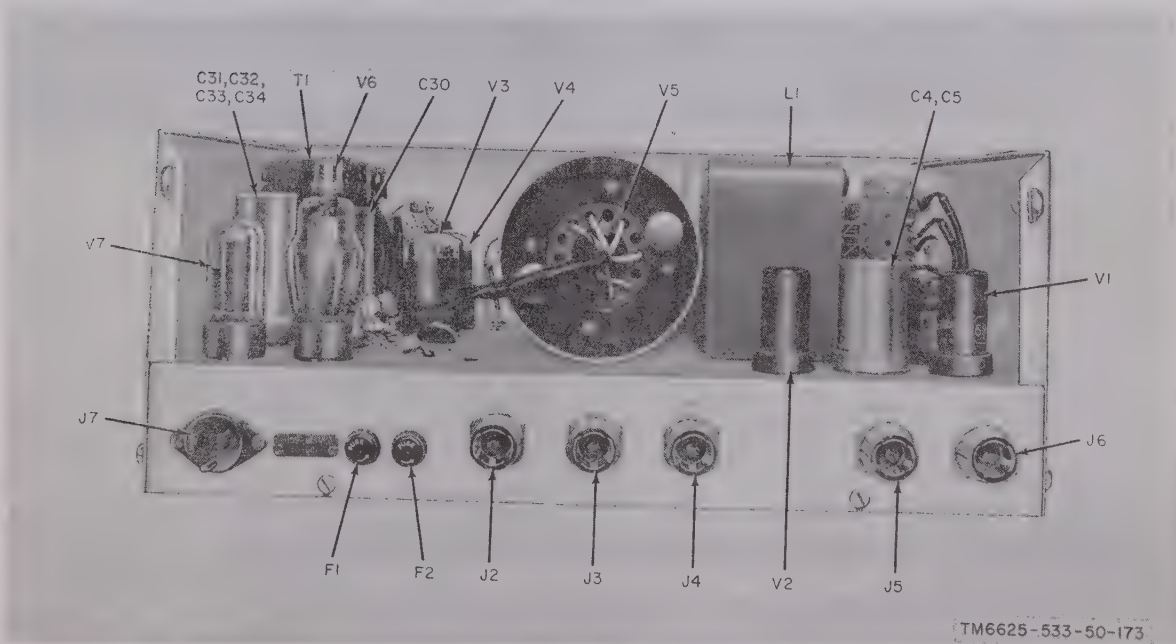


Figure 2–54. Oscilloscope OS–16A/URM–18, rear view.

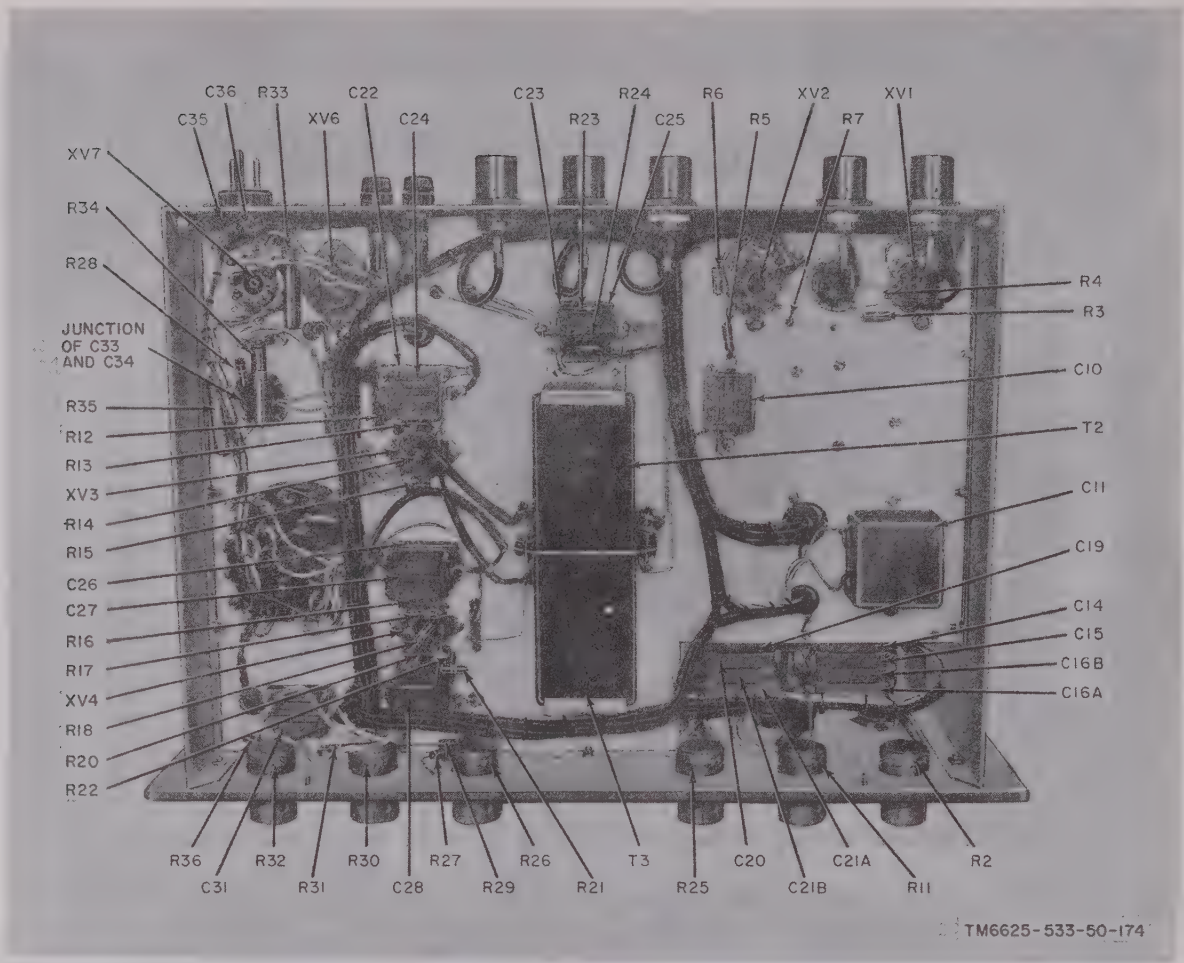


Figure 2–55. Oscilloscope OS–16A/URM–18, bottom view.

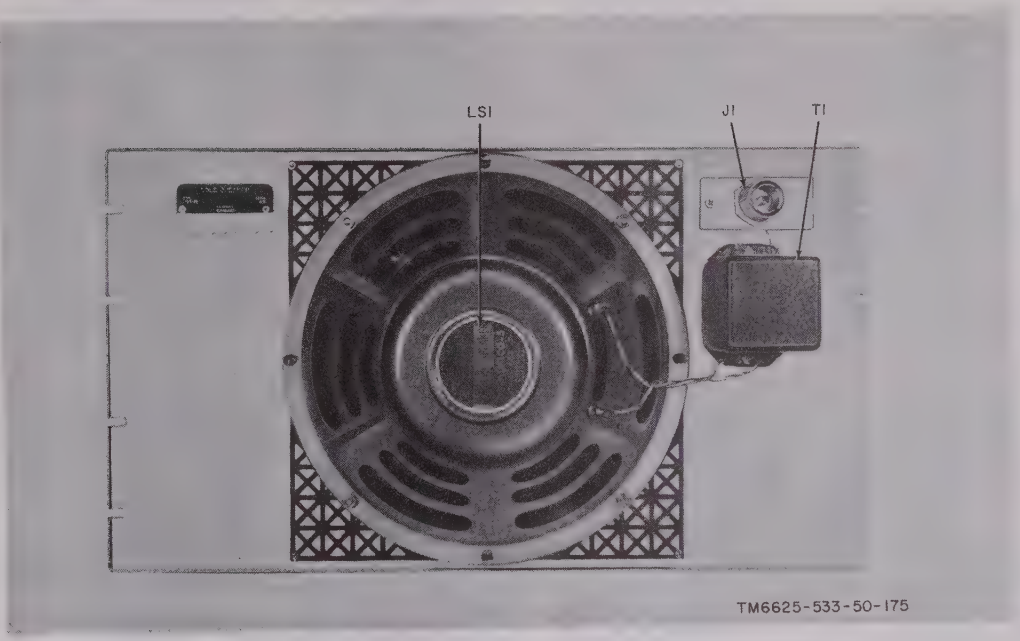


Figure 2–56. Loudspeaker, Magnetic LS–205/U, rear view.

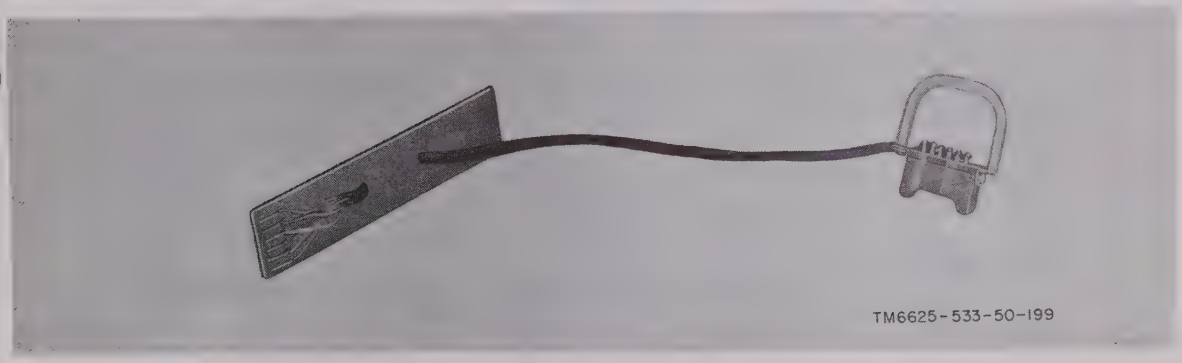
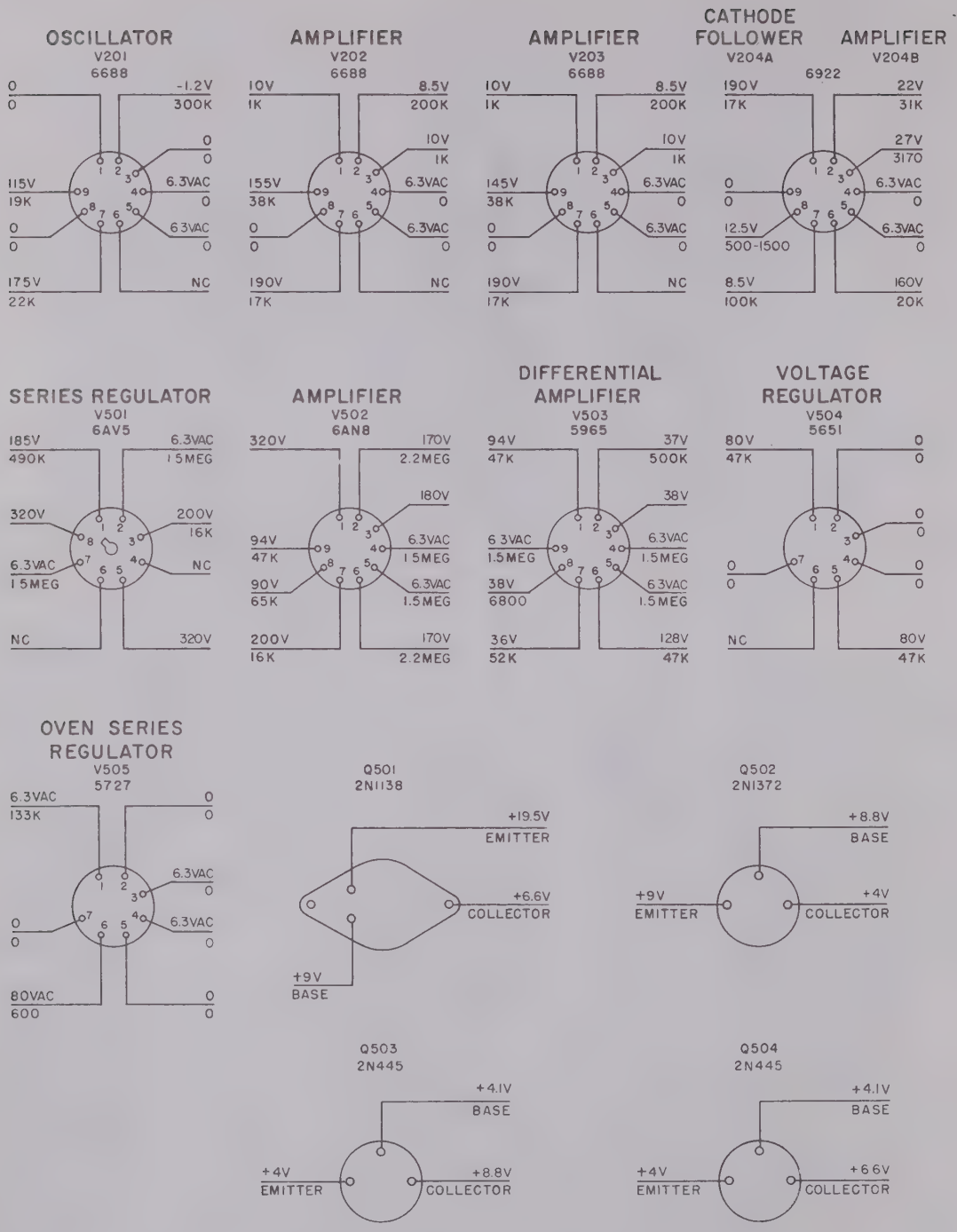


Figure 2–57. Extension cable for plug-in units in Frequency Divider CV–1517/URM–18A.



NOTES

1. ALL MEASUREMENTS ARE MADE WITH A 20,000 OHM PER VOLT METER.
2. POWER INPUT: 115V, 60CPS.
3. RESISTANCE MEASUREMENTS ARE MADE WITH POWER DISCONNECTED AND POWER SWITCH AT STANDBY ONLY
4. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.

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Figure 2-58. Standard Frequency Oscillator O-1106/URM-18A, tube socket and transistor socket voltage and resistance chart.

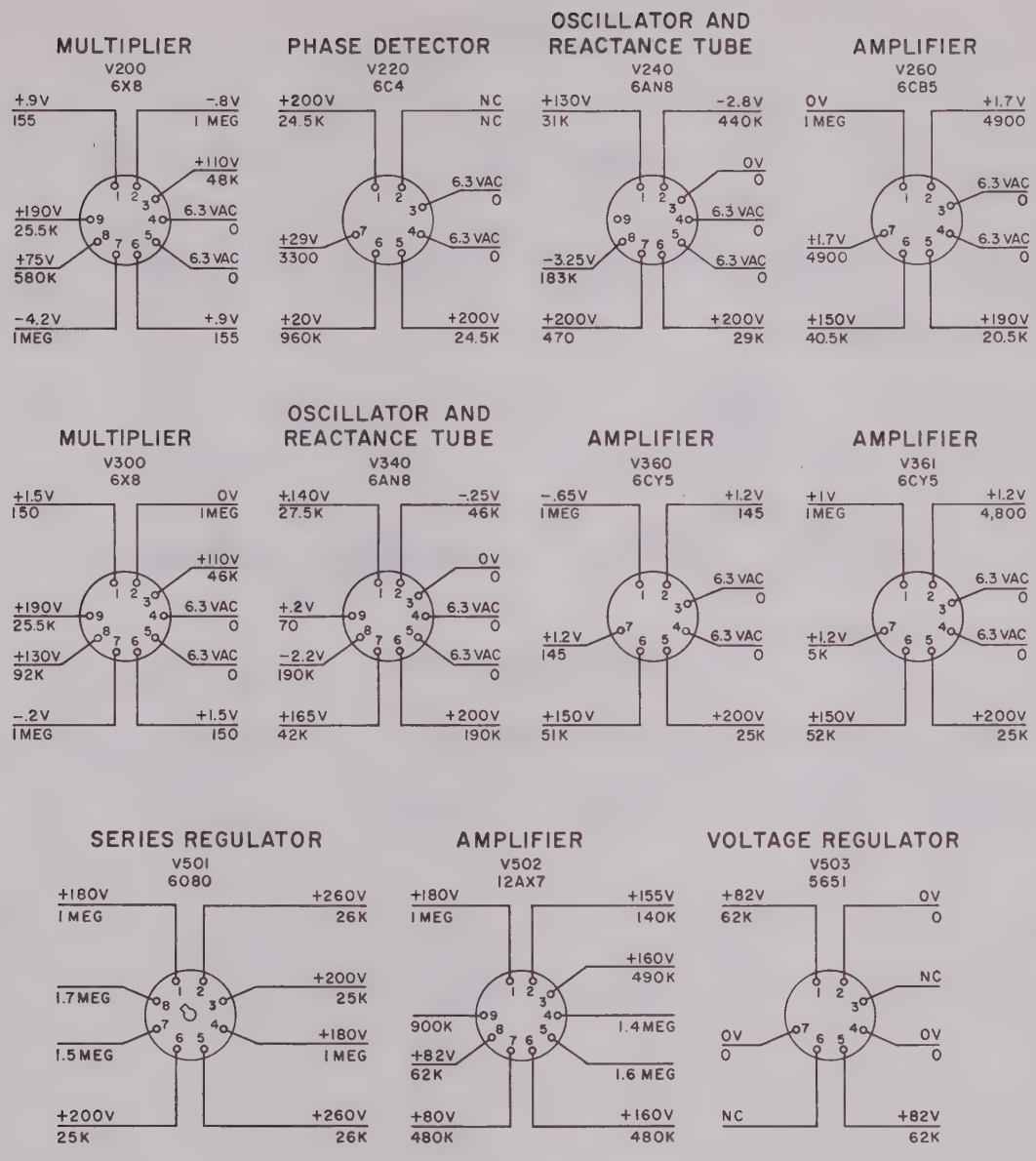


Figure 2–59. Frequency Multiplier CV–1518/URM–18A, tube socket voltage and resistance chart.

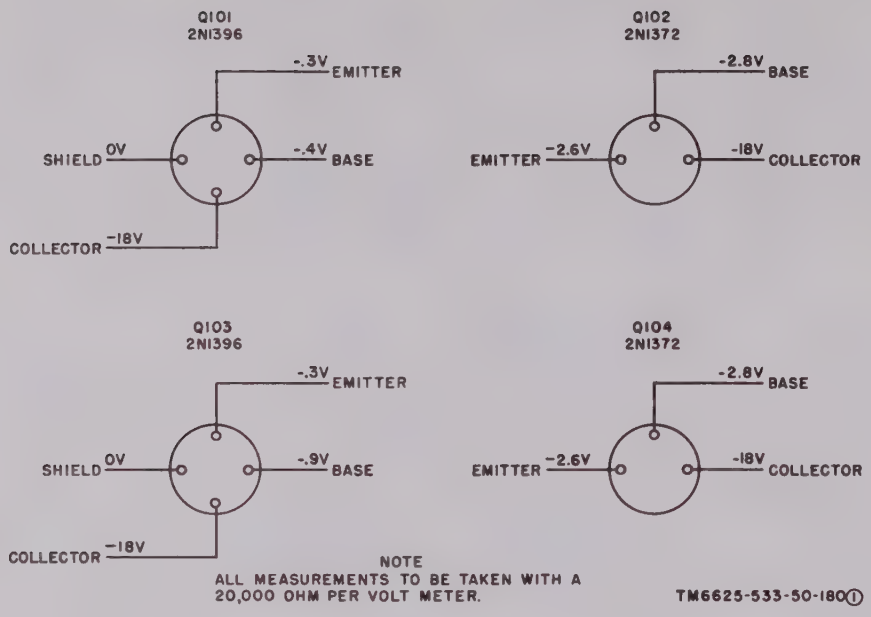


Figure 2–60①. Frequency Divider CV–1517/URM–18A, transistor socket voltage (part 1 of 5).

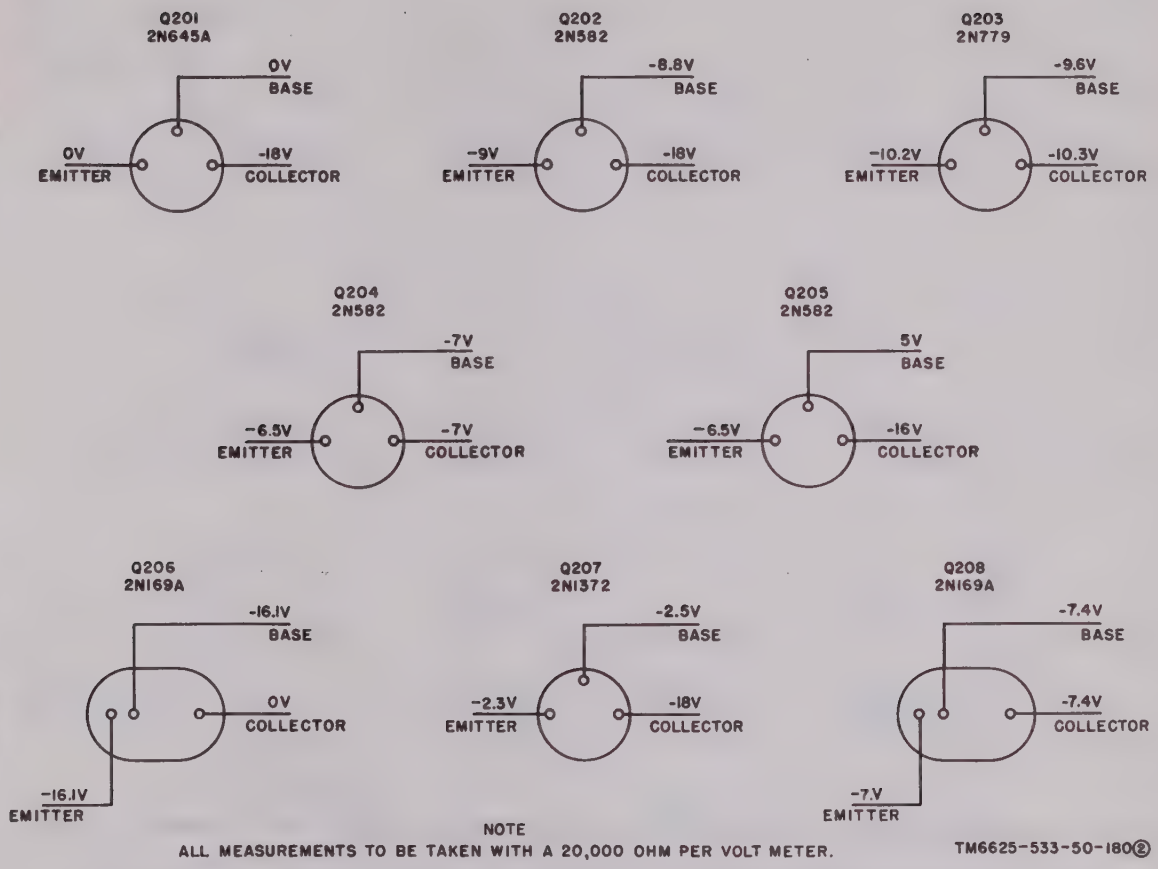


Figure 2–60 ②. Frequency Divider CV–1517/URM–18A, transistor socket voltage (part 2 of 5).

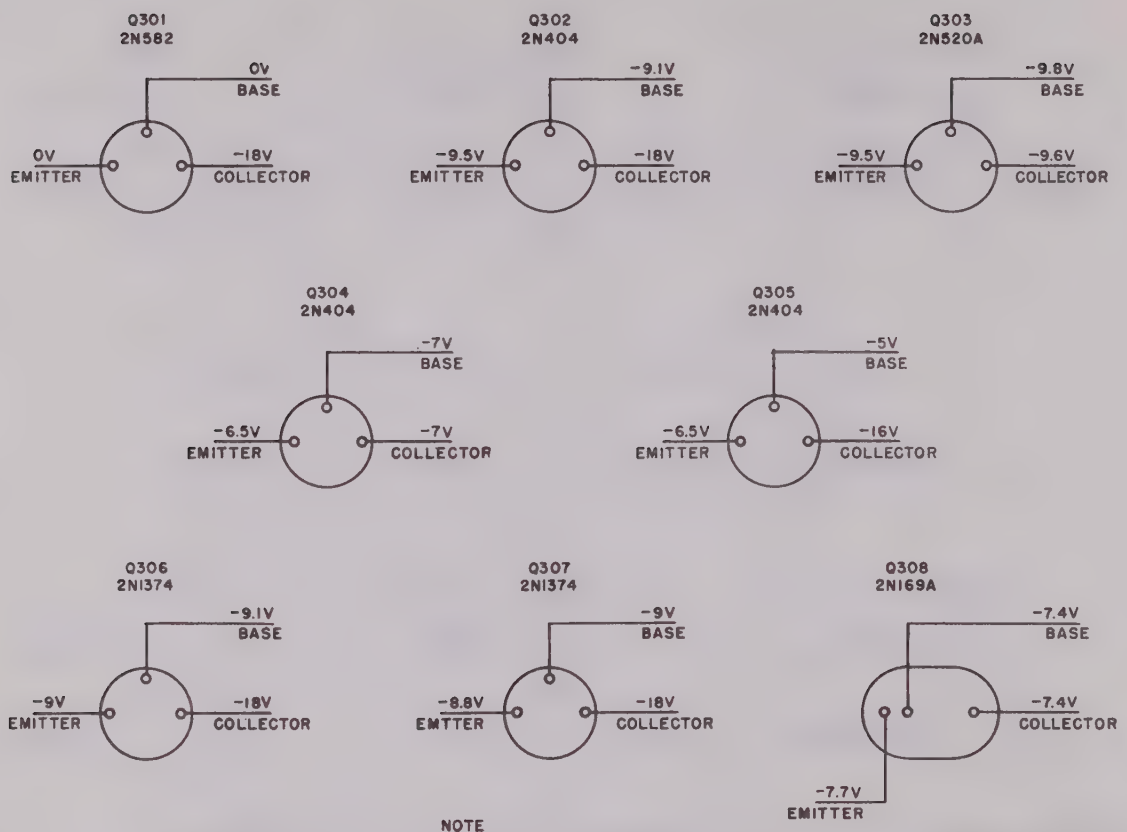
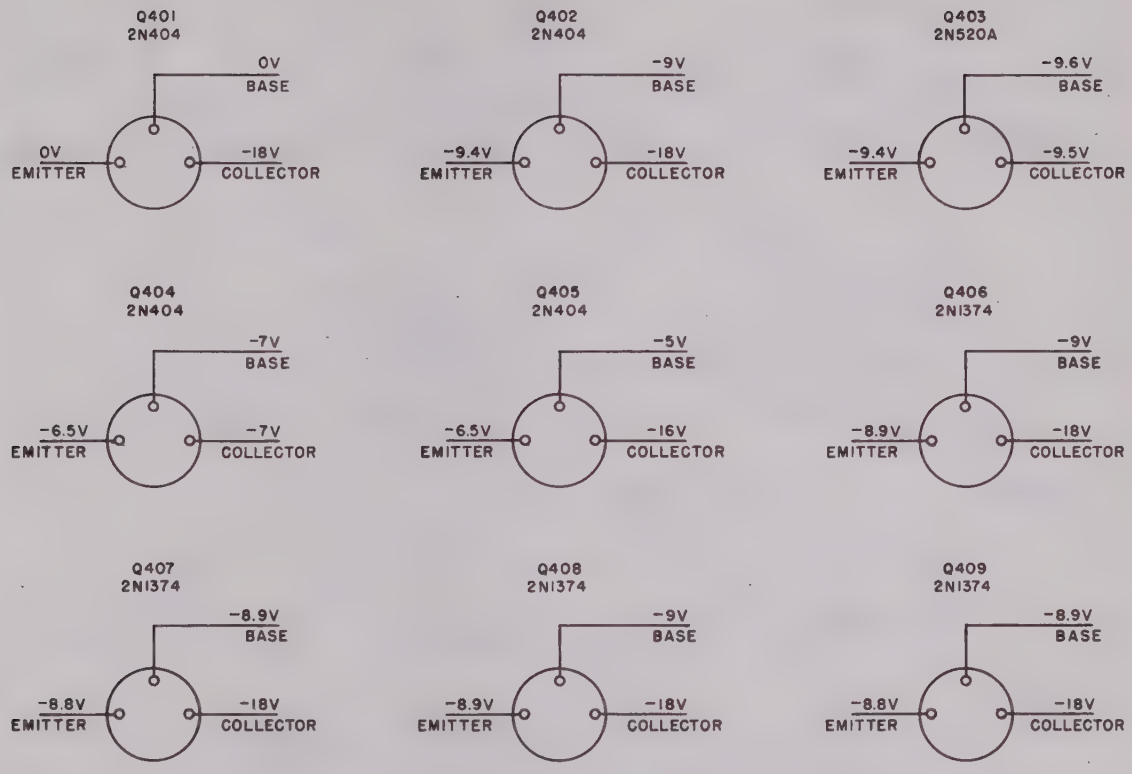


Figure 2-60 ③. Frequency Divider CV-1517/URM-18A, transistor socket voltage (part 3 of 5).



NOTE

ALL MEASUREMENTS TO BE TAKEN WITH A 20,000 OHM PER VOLT METER.

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Figure 2-60 ④. Frequency Divider CV-1517/URM-18A, transistor socket voltage (part 4 of 5).

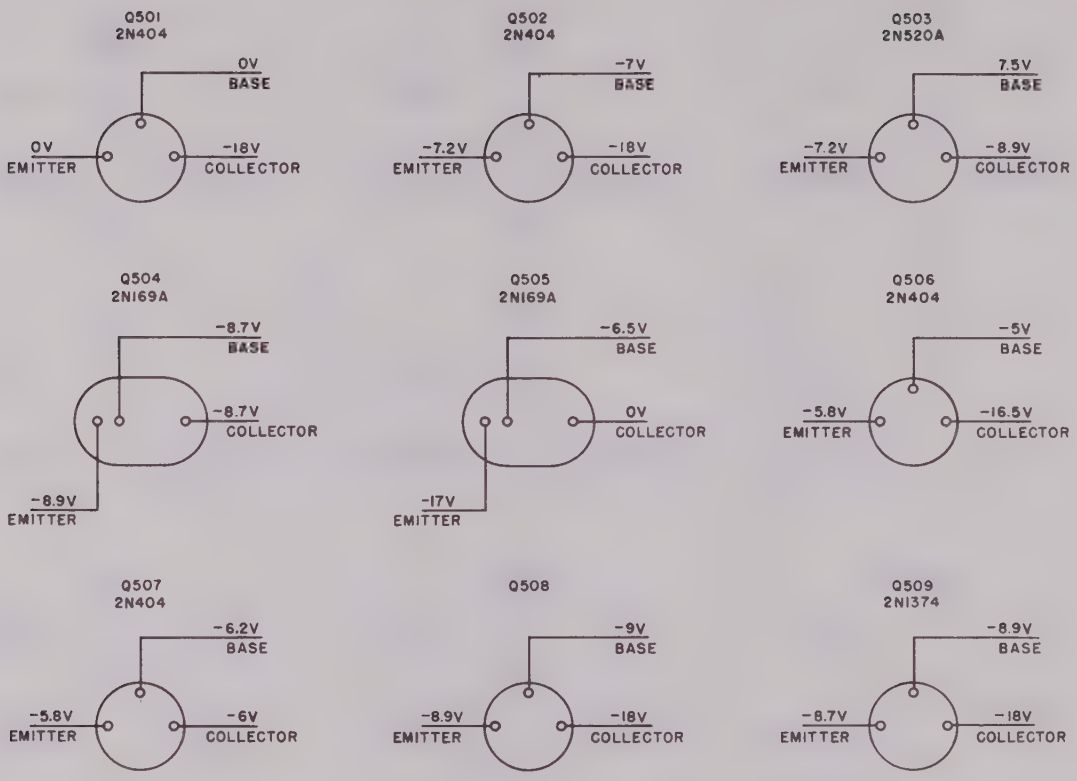


Figure 2-60 ⑤. Frequency Divider CV-1517/URM-18A, transistor socket voltage (part 5 of 5).

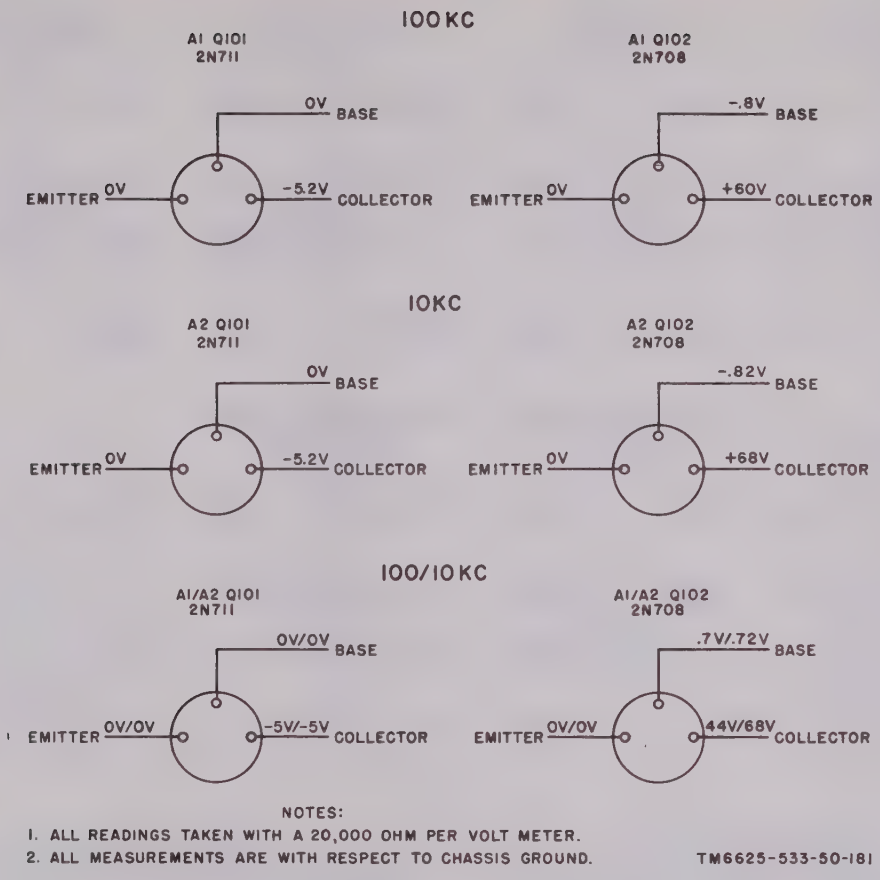
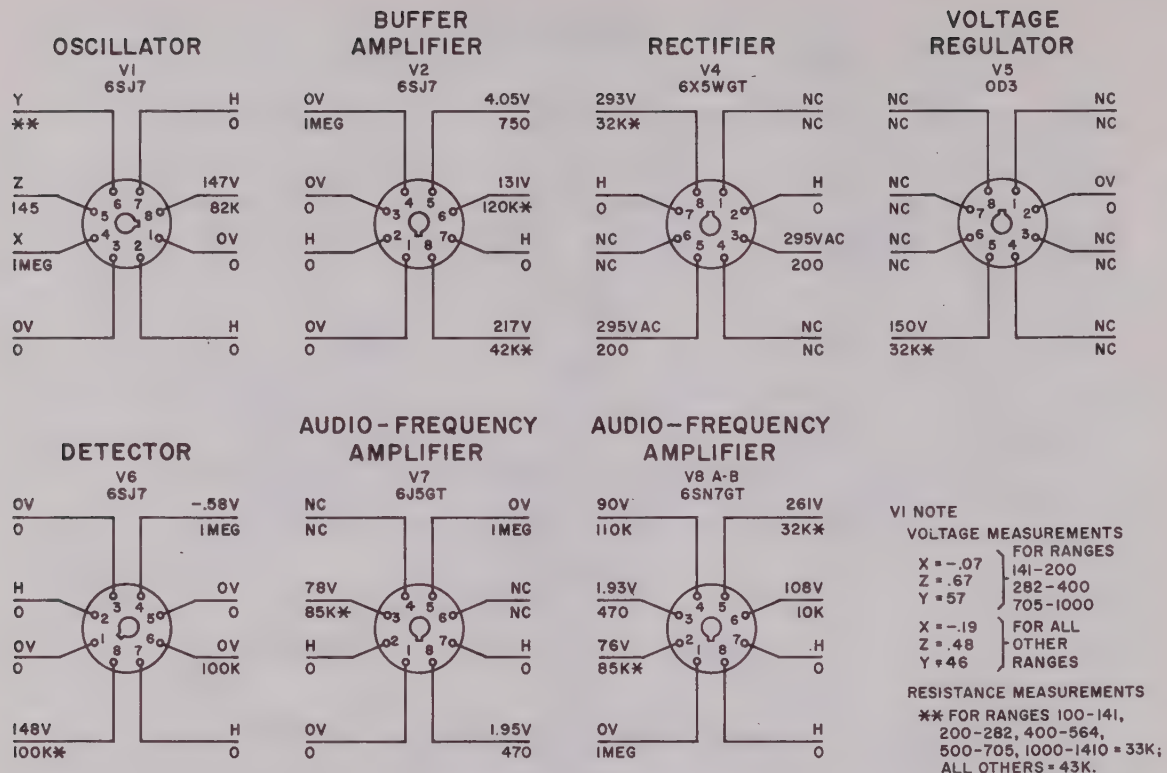


Figure 2–61. Control Panel SB–105A/URM–18, transistor socket voltage.



V1 NOTE

VOLTAGE MEASUREMENTS

X = -.07 Z = .67 Y = 57	FOR RANGES 141-200, 282-400, 705-1000
X = -.19 Z = .48 Y = 46	FOR ALL OTHER RANGES

RESISTANCE MEASUREMENTS

** FOR RANGES 100-141, 200-282, 400-564, 500-705, 1000-1410 = 33K; ALL OTHERS = 43K.

NOTES

VOLTAGE MEASUREMENTS

1. ALL DC MEASUREMENTS ARE MADE BETWEEN THE SOCKET TERMINAL AND GROUND (CHASSIS) WITH THE TUBE OPERATING EXCEPT FOR THE HEATERS WHICH ARE MEASURED BETWEEN THE TERMINALS INDICATED H TO BE 6.3 VOLTS AC.
2. DC VOLTAGES ARE MEASURED WITH A 20,000-OHMS-PER-VOLT METER, AND AC VOLTAGES WITH A 1,000-OHMS-PER-VOLT METER.
3. ALL READINGS ARE SUBJECT TO 10-PERCENT VARIATION.
4. SET BOTH FREQUENCY METER DIAL AND DETECTOR DIAL TO 120 KC.
5. RANGE SWITCHES TO 100-141 KC.
6. REGENERATION CONTROL FULL CCW POSITION.
7. PLATE SWITCH TO PLATE
8. LINE VOLTAGE -117 VOLTS, INPUT POWER -42 WATTS.
9. VOLTAGE READINGS ARE ABOVE LINE.

RESISTANCE MEASUREMENTS

1. ALL MEASUREMENTS ARE MADE WITH A VTVM BETWEEN SOCKET TERMINAL AND GROUND (CHASSIS) WITH TUBE REMOVED.
2. REGENERATION CONTROL FULL CCW POSITION.
3. RANGE SWITCHES SET TO 141-200.
4. PLATE SWITCH SET TO OFF.
5. VALUES ARE IN OHMS.
6. READINGS SUBJECT TO 10-PERCENT VARIATION EXCEPT WHERE STARRED (*).
7. VALUES STARRED (*) ARE READ AFTER THE VTVM HAS STOPPED DRIFTING. THE VTVM LEADS MUST THEN BE REVERSED, AND THE HIGHER OF THE TWO READINGS MUST BE USED BECAUSE OF LARGE CAPACITORS IN THE CIRCUIT. THESE VALUES ARE SUBJECT TO 20-PERCENT VARIATION.
8. RESISTANCE READINGS ARE BELOW LINE.

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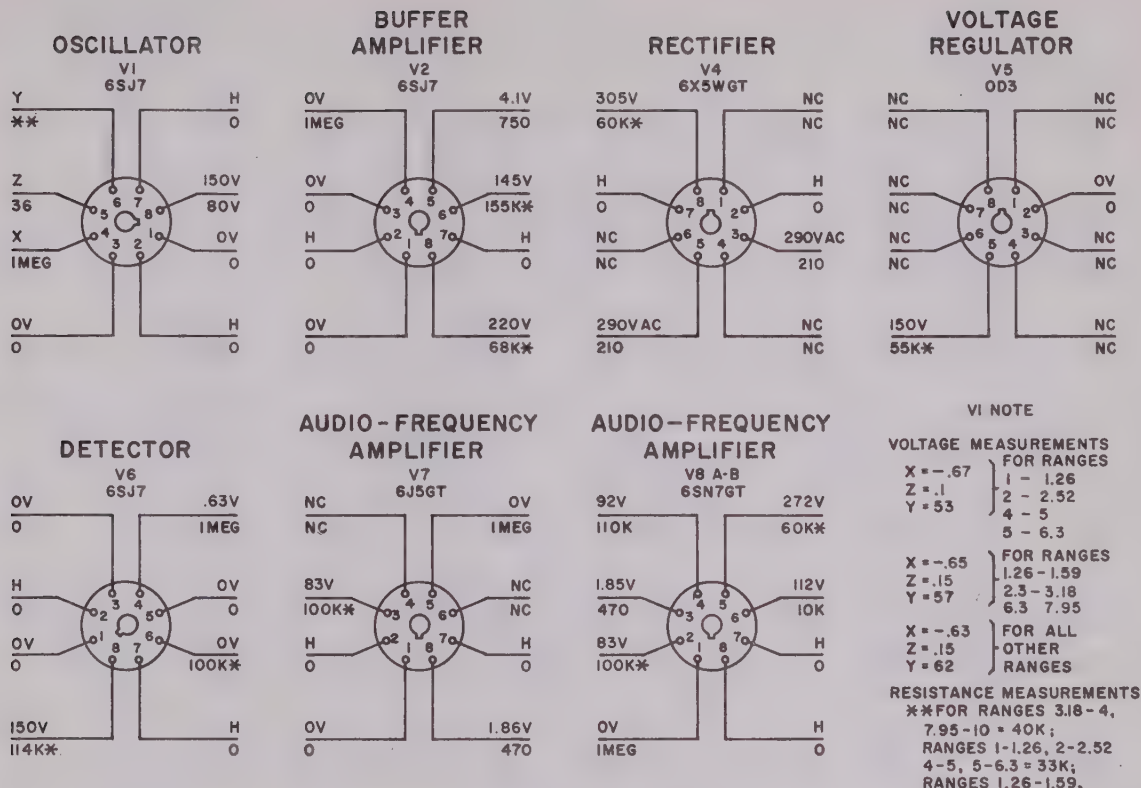
Figure 2-62. Frequency Meter FR-43A/URM-18, tube socket voltage and resistance chart.



VI NOTE

VOLTAGE MEASUREMENTS

X = −.67 Z = .1 Y = 53	FOR RANGES 1 − 1.26 2 − 2.52 4 − 5 5 − 6.3
X = −.65 Z = .15 Y = 57	FOR RANGES 1.26 − 1.59 2.3 − 3.18 6.3 7.95
X = −.63 Z = .15 Y = 62	FOR ALL OTHER RANGES

RESISTANCE MEASUREMENTS

**FOR RANGES 3.18 − 4, 7.95 − 10 = 40K; RANGES 1 − 1.26, 2 − 2.52 4 − 5, 5 − 6.3 = 33K; RANGES 1.26 − 1.59, 2.52 − 3.18, 6.3 − 7.95 = 36K.

NOTES

VOLTAGE MEASUREMENTS

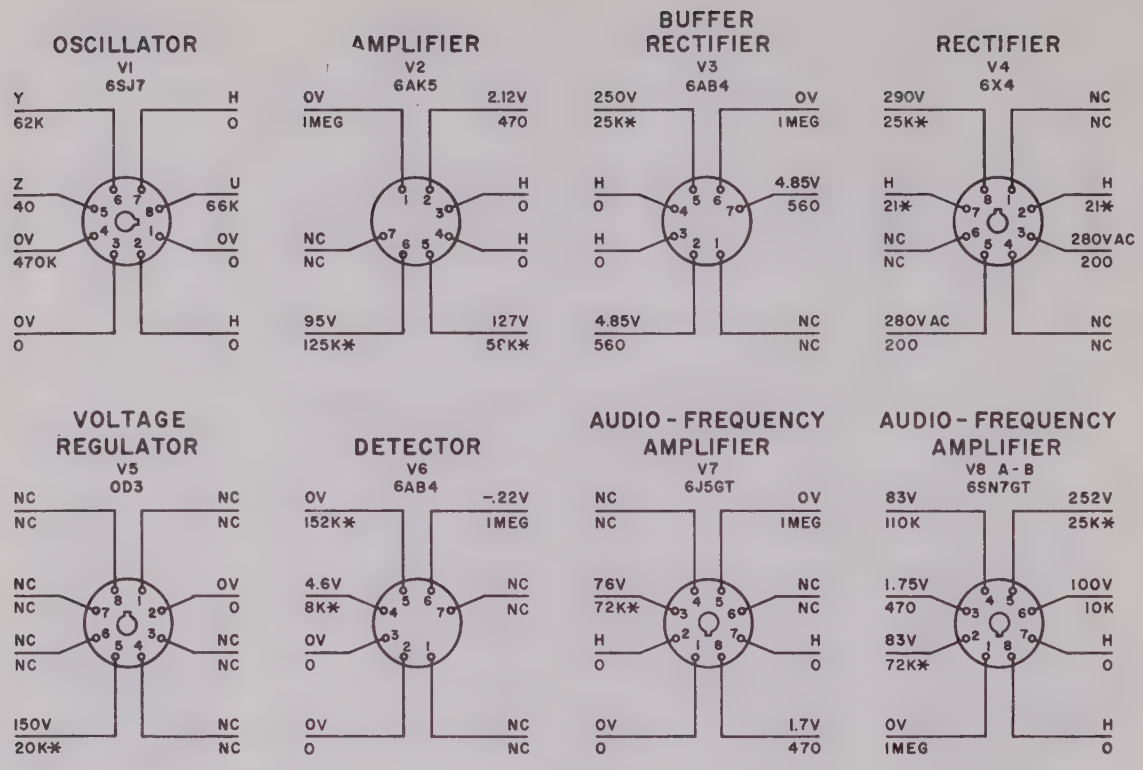
1. ALL DC MEASUREMENTS ARE MADE BETWEEN THE SOCKET TERMINAL AND GROUND (CHASSIS) WITH THE TUBE OPERATING EXCEPT FOR THE HEATERS WHICH ARE MEASURED BETWEEN THE TERMINALS INDICATED H TO BE 6.3 VOLTS AC.
2. DC VOLTAGES ARE MEASURED WITH A 20,000-OHMS-PER-VOLT METER, AND AC VOLTAGES WITH A 1,000-OHMS-PER-VOLT METER.
3. ALL READINGS ARE SUBJECT TO 10-PERCENT VARIATION.
4. SET BOTH [FREQUENCY METER] DIAL AND [DETECTOR] DIAL TO 1.80MC.
5. [RANGE] SWITCHES TO 1.59 - 2.00
6. [REGENERATION] CONTROL FULL CCW POSITION.
7. [PLATE] SWITCH TO [PLATE]
8. LINE VOLTAGE −117 VOLTS, INPUT POWER −42 WATTS.
9. VOLTAGE READINGS ARE ABOVE LINE.

RESISTANCE MEASUREMENTS

1. ALL MEASUREMENTS ARE MADE WITH A VTVM BETWEEN SOCKET TERMINAL AND GROUND (CHASSIS) WITH TUBE REMOVED.
2. [REGENERATION] CONTROL FULL CCW POSITION.
3. [RANGE] SWITCHES SET TO 1.59 - 2.00
4. [PLATE] SWITCH SET TO [OFF].
5. VALUES ARE IN OHMS.
6. READINGS SUBJECT TO 10-PERCENT VARIATION EXCEPT WHERE STARRED (*).
7. VALUES STARRED (*) ARE READ AFTER THE VTVM HAS STOPPED DRIFTING. THE VTVM LEADS MUST THEN BE REVERSED, AND THE HIGHER OF THE TWO READINGS MUST BE USED BECAUSE OF LARGE CAPACITORS IN THE CIRCUIT. THESE VALUES ARE SUBJECT TO 20-PERCENT VARIATION.
8. RESISTANCE READINGS ARE BELOW LINE.

TM6625-533-50-183

Figure 2-63. Frequency Meter FR-44/URM-18, tube socket voltage and resistance chart.



V1 NOTE

VOLTAGE MEASUREMENTS

Z = .32, Y = 96, U = 149	FOR RANGES 12.6-15.9, 25.2-31.8, 63-79	
Z = .47, Y = 123, U = 143	FOR RANGES 15.9-200, 31.8-400, 79.5-1000	
Z = .26, Y = 96, U = 149	FOR ALL OTHER RANGES	

NOTES

VOLTAGE MEASUREMENTS

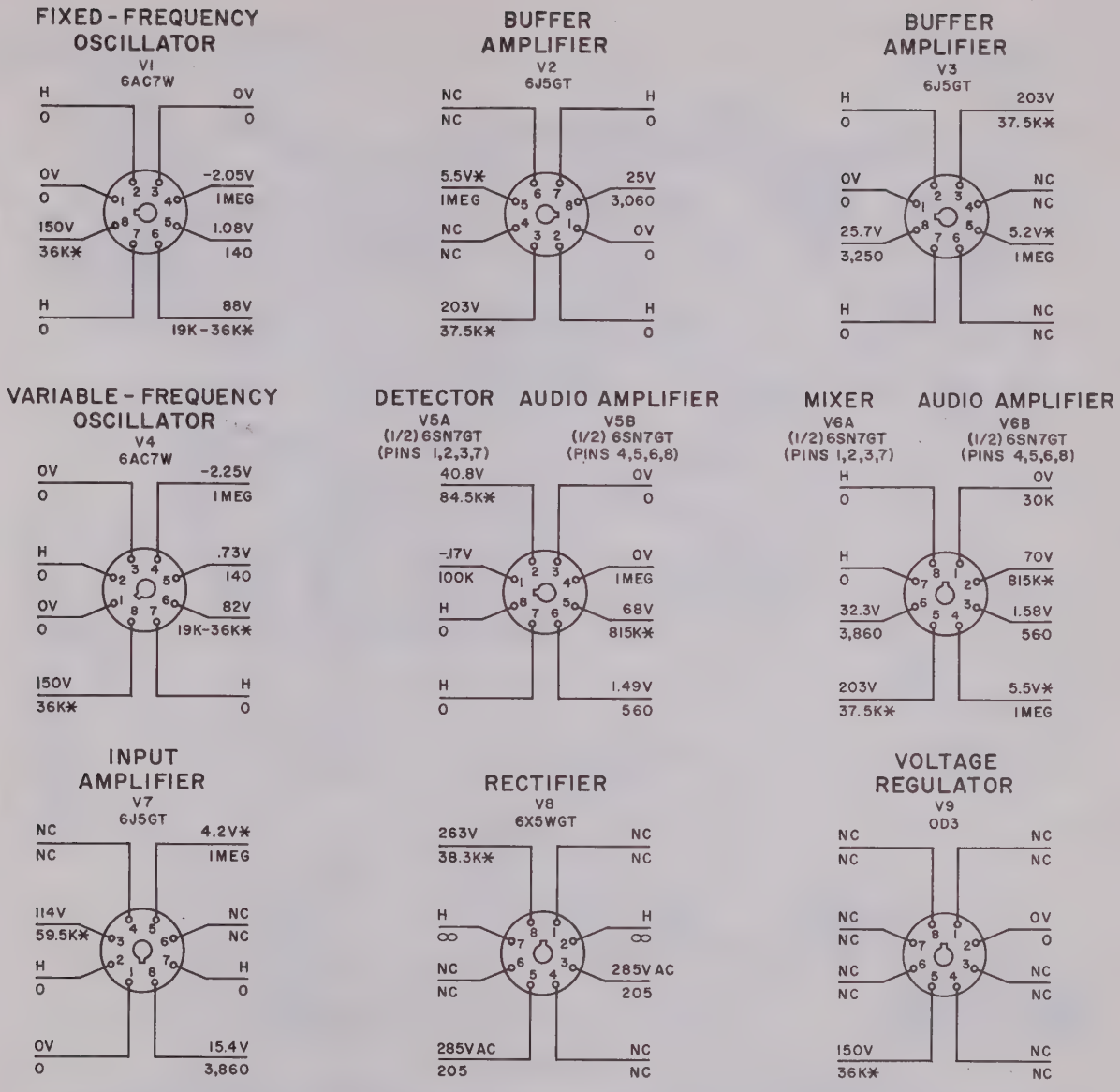
1. ALL DC MEASUREMENTS ARE MADE BETWEEN THE SOCKET TERMINAL AND GROUND (CHASSIS) WITH THE TUBE OPERATING EXCEPT FOR THE HEATERS WHICH ARE MEASURED BETWEEN THE TERMINALS INDICATED H TO BE 6.3 VOLTS AC.
2. DC VOLTAGES ARE MEASURED WITH A 20,000-OHMS-PER-VOLT METER, AND AC VOLTAGES WITH A 1,000-OHMS-PER-VOLT METER.
3. ALL READINGS ARE SUBJECT TO 10-PERCENT VARIATION.
4. SET BOTH [FREQUENCY METER] DIAL AND [DETECTOR] DIAL TO 11.3.
5. [RANGE] SWITCHES TO 10.0-12.6.
6. [REGENERATION] CONTROL FULL CCW POSITION.
7. [PLATE] SWITCH TO [PLATE].
8. LINE VOLTAGE 117 VOLTS.
9. USE CAUTION WHEN MEASURING THE DC FILAMENT VOLTAGE FOR V6.
10. VOLTAGE READINGS ARE ABOVE LINE.

RESISTANCE MEASUREMENTS

1. ALL MEASUREMENTS ARE MADE WITH A VTVM BETWEEN SOCKET TERMINAL AND GROUND (CHASSIS) WITH TUBE REMOVED.
2. [REGENERATION] CONTROL FULL CCW POSITION.
3. [RANGE] SWITCHES SET TO 15.9-20.0.
4. [PLATE] SWITCH SET TO [OFF].
5. VALUES ARE IN OHMS.
6. READINGS SUBJECT TO 10-PERCENT VARIATION EXCEPT WHERE STARRED (*)
7. VALUES STARRED (*) ARE READ AFTER THE VTVM HAS STOPPED DRIFTING. THE VTVM LEADS MUST THEN BE REVERSED, AND THE HIGHER OF THE TWO READINGS MUST BE USED BECAUSE OF LARGE CAPACITORS IN THE CIRCUIT. THESE VALUES ARE SUBJECT TO 20-PERCENT VARIATION.
8. RESISTANCE READINGS ARE BELOW LINE.

TM6625-533-50-184

Figure 2-64. Frequency Meter FR-45A/URM-18, tube socket voltage and resistance chart.



NOTES

VOLTAGE MEASUREMENTS

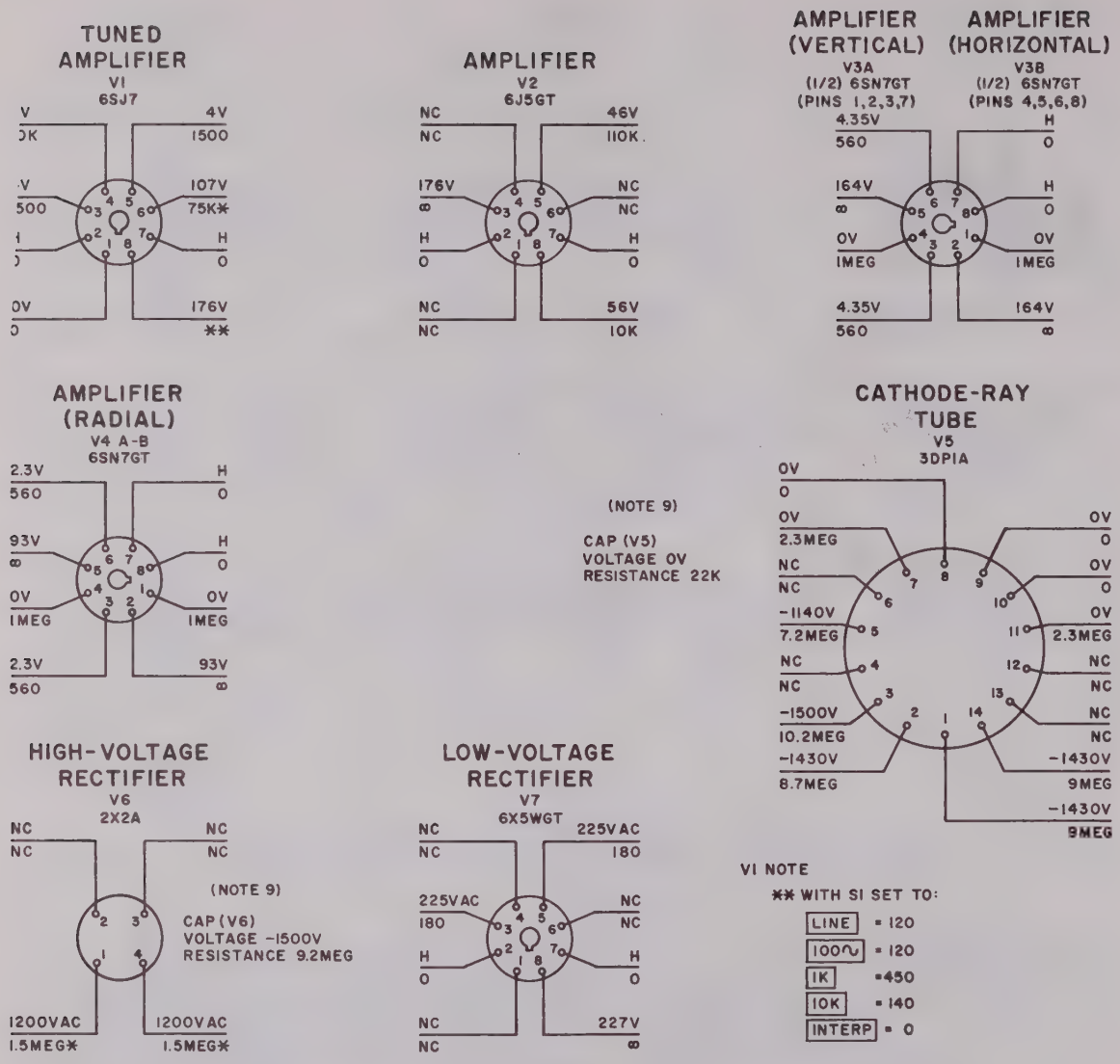
1. ALL DC MEASUREMENTS ARE MADE BETWEEN THE SOCKET TERMINAL AND GROUND (CHASSIS) WITH THE TUBE OPERATING EXCEPT FOR THE HEATERS WHICH ARE MEASURED BETWEEN THE TERMINALS INDICATED H TO BE 6.3 VOLTS AC.
2. MAIN FREQUENCY DIAL TO THE 100-CYCLE POINT.
3. REVERSE-DIRECT SWITCH TO DIRECT.
4. INPUT CONTROL AND OUTPUT CONTROL SET FULL CCW POSITION.
5. DC VOLTAGES ARE MEASURED WITH A 20,000-OHMS-PER-VOLT METER AND AC VOLTAGES WITH A 1,000-OHMS-PER-VOLT METER, VALUES STARRED (*) ARE READ ON THE 50-VOLT RANGE OF THE VOLTMETER.
6. ALL READINGS ARE SUBJECT TO 10-PERCENT VARIATION.
7. LINE VOLTAGE 117 VOLTS.
8. VOLTAGE READINGS ARE ABOVE LINE.

RESISTANCE MEASUREMENTS

1. ALL MEASUREMENTS ARE MADE WITH A VTVM BETWEEN SOCKET TERMINAL AND GROUND (CHASSIS) WITH TUBE REMOVED.
2. REVERSE-DIRECT SWITCH SET TO DIRECT.
3. OUTPUT CONTROL CW.
4. VALUES ARE IN OHMS.
5. READINGS SUBJECT TO 10 PERCENT VARIATION EXCEPT WHERE STARRED (*).
6. VALUES STARRED (*) ARE READ AFTER THE VTVM HAS STOPPED DRIFTING. THE VTVM LEADS THEN MUST BE REVERSED, AND THE HIGHER OF THE TWO READINGS MUST BE USED BECAUSE OF LARGE CAPACITORS IN THE CIRCUIT. THESE VALUES ARE SUBJECT TO 20-PERCENT VARIATION.
7. RESISTANCE READINGS ARE BELOW LINE.

TM6625-533-50-185

Figure 2-65. Signal Generator SG-42/URM-18, tube socket voltage and resistance chart.



NOTES

VOLTAGE MEASUREMENTS

1. ALL DC MEASUREMENTS ARE MADE BETWEEN THE SOCKET TERMINAL AND GROUND (CHASSIS) WITH THE TUBE OPERATING EXCEPT FOR THE HEATERS WHICH ARE MEASURED BETWEEN THE TERMINALS INDICATED H TO BE 6.3 VOLTS AC, EXCEPT FOR V6 WHICH IS 2.5 VOLTS AC.
2. DC VOLTAGES ARE MEASURED WITH A 20,000-OHMS-PER-VOLT METER, AND AC VOLTAGE WITH A 1000-OHMS-PER-VOLT METER.
3. LINE VOLTAGE -117 VOLTS, INPUT POWER -36 WATTS.
4. ALL READINGS ARE SUBJECT TO 10-PERCENT VARIATION.
5. VERT. CENTERING CONTROL, HORIZ. CENTERING CONTROL, BRILLIANCE CONTROL, AND FOCUS CONTROL FULL CCW POSITION.
6. DIAMETER CONTROL, AND SHAPING CONTROL FULL CW POSITION.
7. CIRCULAR SWEEP FREQUENCY SWITCH TO INC.
8. SELECTOR SWITCH TO INTERP-STD. CIR. SW.
9. WHEN MEASURING THE FILAMENT VOLTAGES TO V5 AND V6, REMOVE HIGH-VOLTAGE RECTIFIER V6 AND USE EXTREME CAUTION.
10. VOLTAGE READINGS ARE ABOVE LINE.

RESISTANCE MEASUREMENTS

1. ALL MEASUREMENTS ARE MADE WITH A VTVM BETWEEN SOCKET TERMINAL AND GROUND (CHASSIS) WITH TUBE REMOVED.
2. VERT. CENTERING CONTROL, HORIZ. CENTERING CONTROL, BRILLIANCE CONTROL, AND FOCUS CONTROL CCW.
3. DIAMETER CONTROL, AND SHAPING CONTROL SET CW.
4. CIRCULAR SWEEP FREQUENCY SWITCH TO LINE.
5. GROUND TO CHASSIS TERMINAL NO. 3 OF L1.
6. VALUES ARE IN OHMS.
7. READINGS SUBJECT TO 10-PERCENT VARIATION EXCEPT WHERE STARRED (*).
8. VALUES STARRED (*) ARE READ AFTER THE VTVM HAS STOPPED DRIFTING. THE VTVM LEADS MUST THEN BE REVERSED, AND THE HIGHER OF THE TWO READINGS MUST BE USED BECAUSE OF LARGE CAPACITORS IN THE CIRCUIT. THESE VALUES ARE SUBJECT TO 20-PERCENT VARIATION.
9. RESISTANCE READINGS ARE BELOW LINE.

TM6625-533-50-186

Figure 2-66. Oscilloscope OS-16A/URM-18, tube socket voltage and resistance chart.

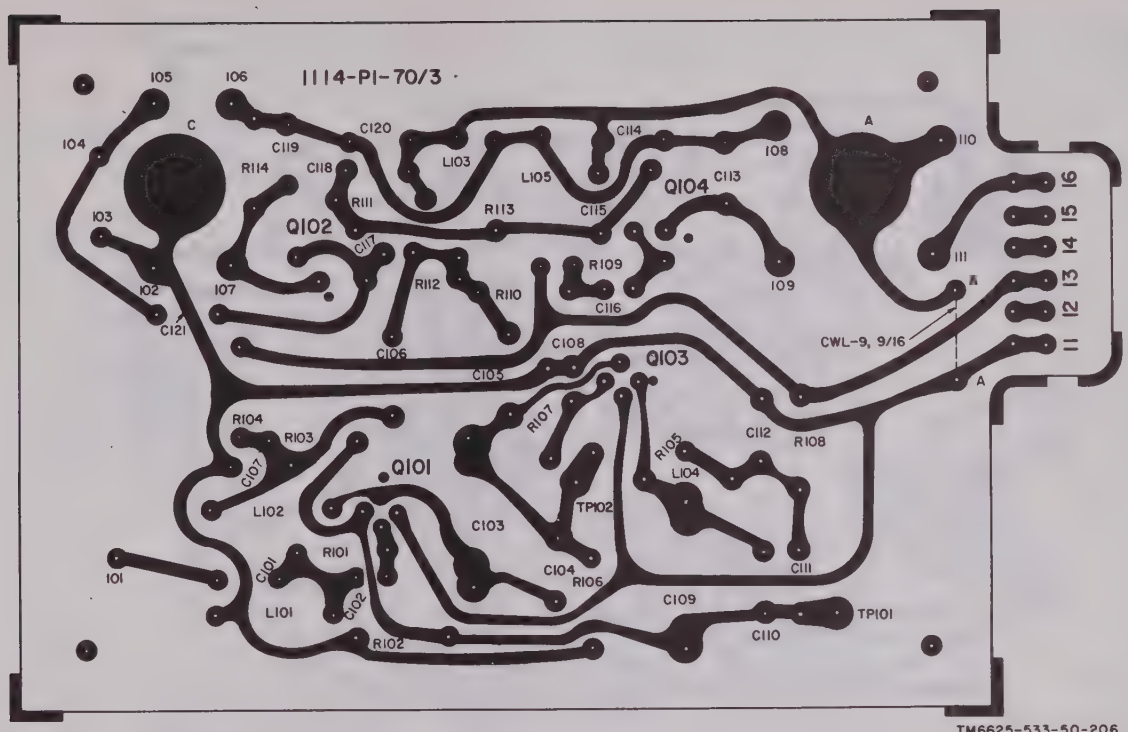


Figure 2–67. Frequency Divider CV–1517/URM–18A, 1114-P1 plug-in unit, circuit board diagram.

Figure 2–68. Frequency Divider CV–1517/URM–18A, 1114-P1 plug-in unit, schematic diagram.

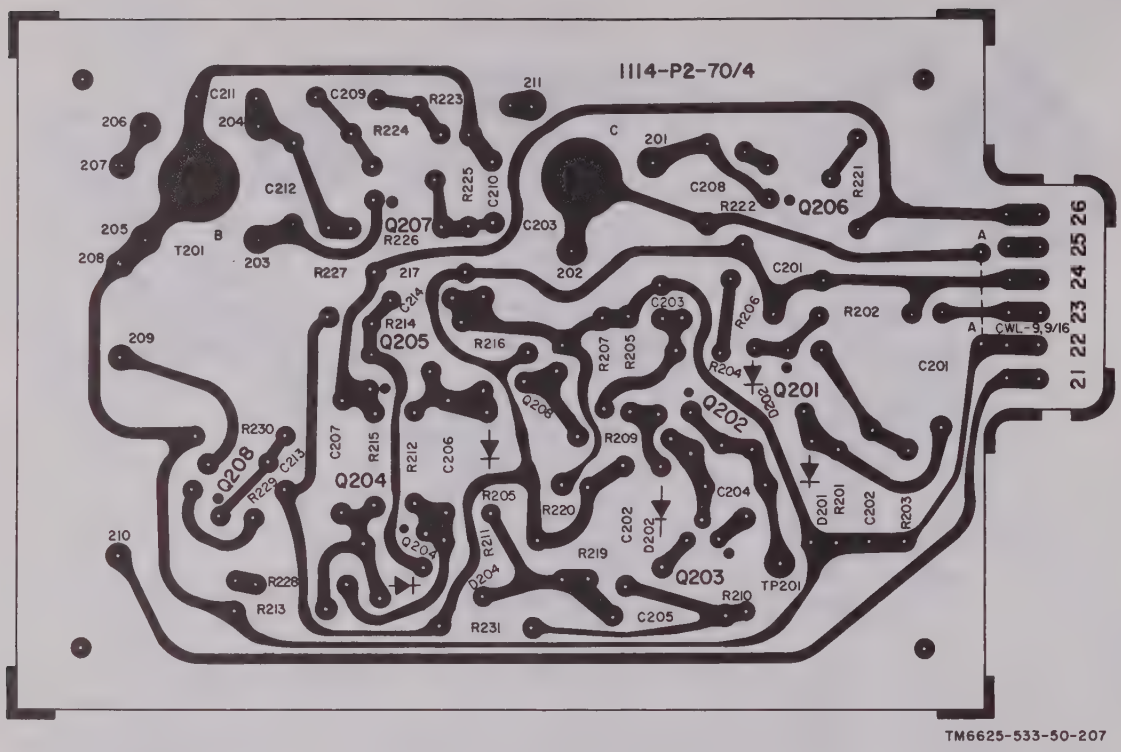
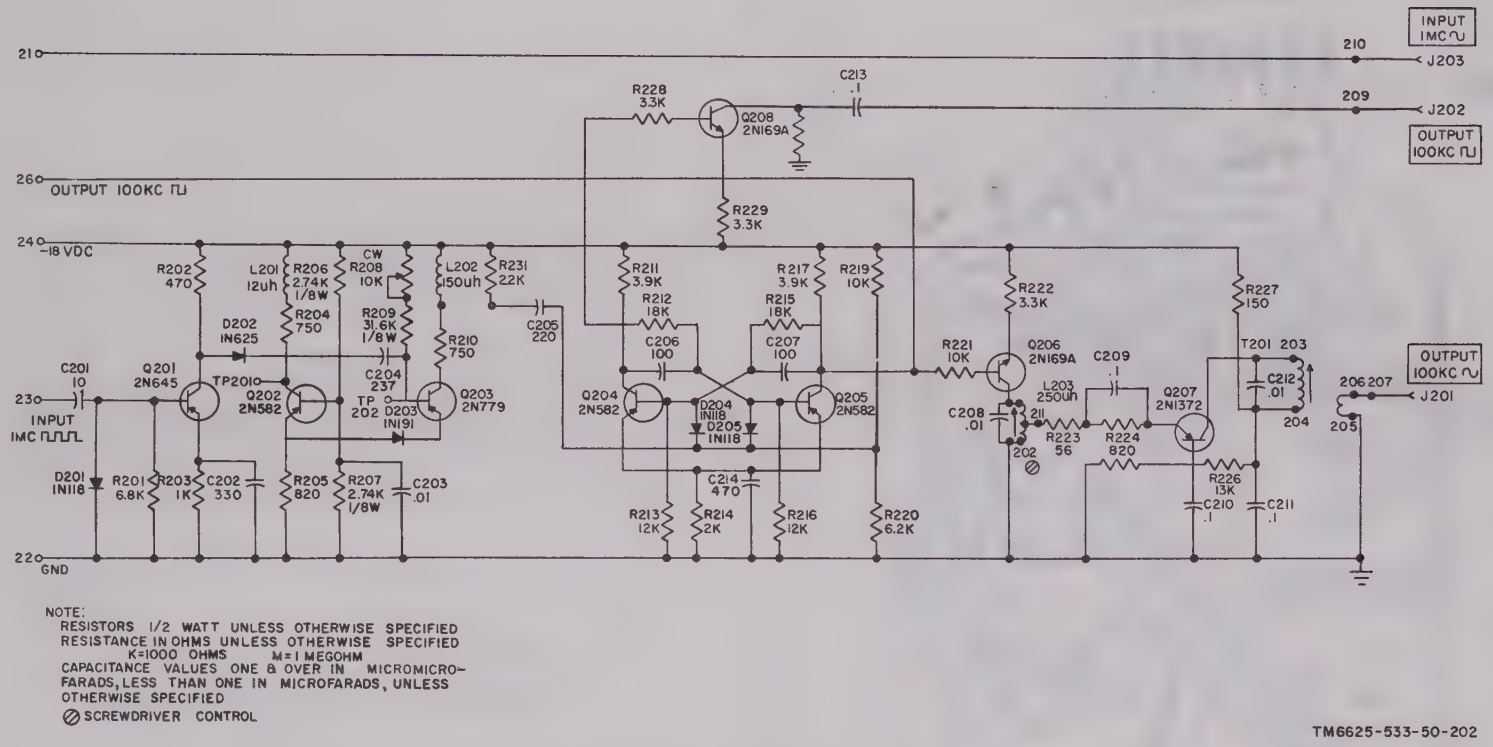


Figure 2–69. Frequency Divider CV–1517/URM–18A, 1114-P2 plug-in unit, circuit board diagram.



NOTE:
RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K=1000 OHMS M=1 MEGOHM
CAPACITANCE VALUES ONE & OVER IN MICROMICRO-FARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED
⊘ SCREWDRIVER CONTROL

TM6625-533-50-202

Figure 2–70. Frequency Divider CV–1517/URM–18A, 1114-P2 plug-in unit, schematic diagram.

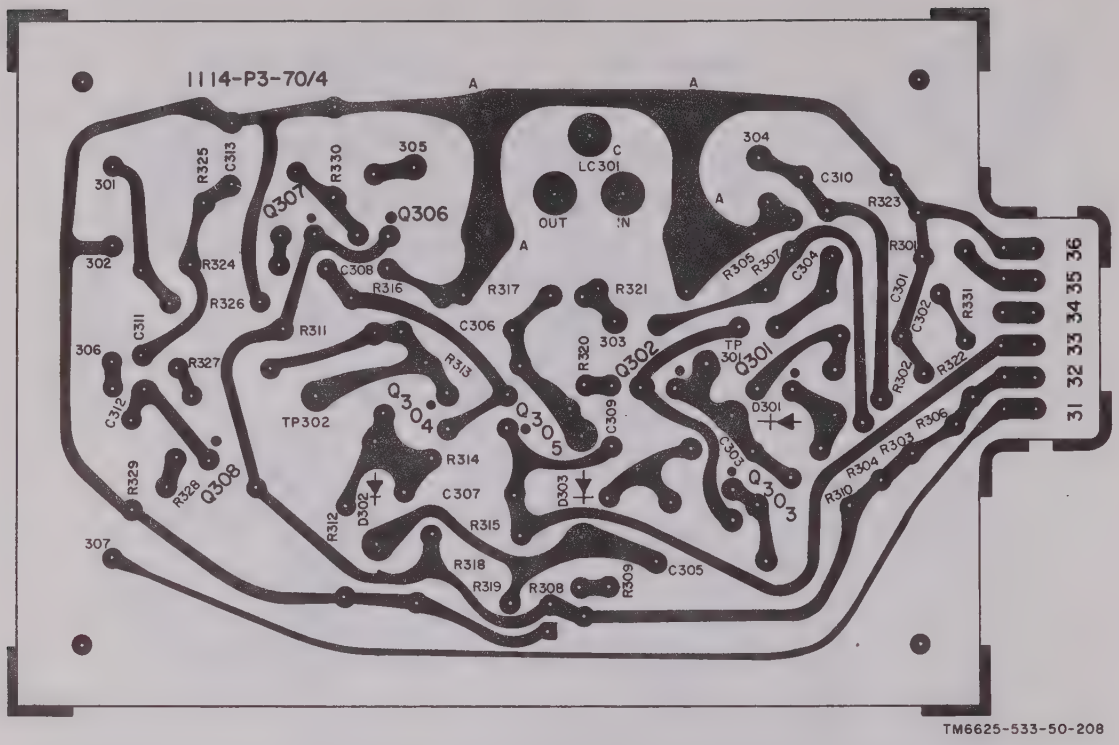
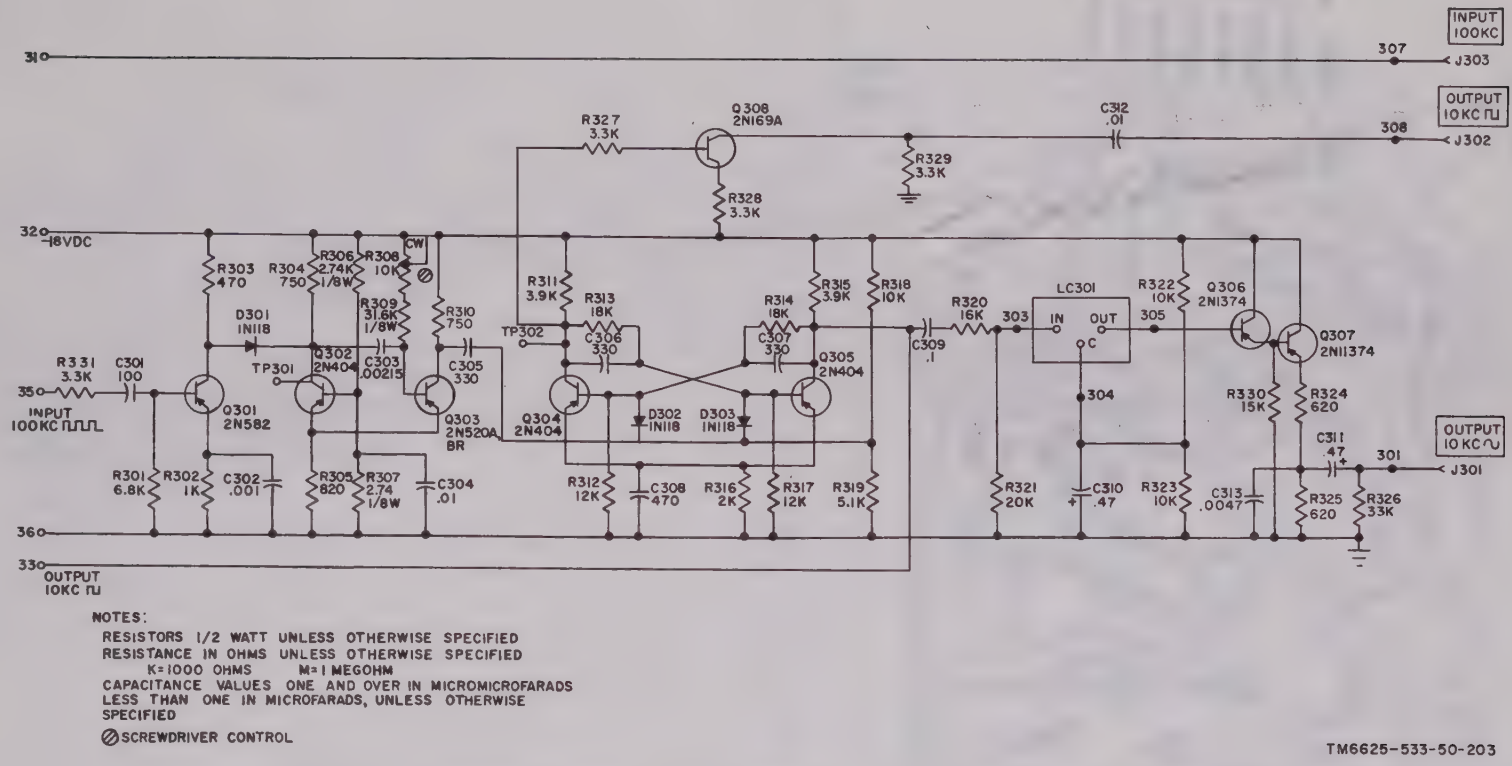


Figure 2–71. Frequency Divider CV–1517/URM–18A, 1114-P3 plug-in unit, circuit board diagram.



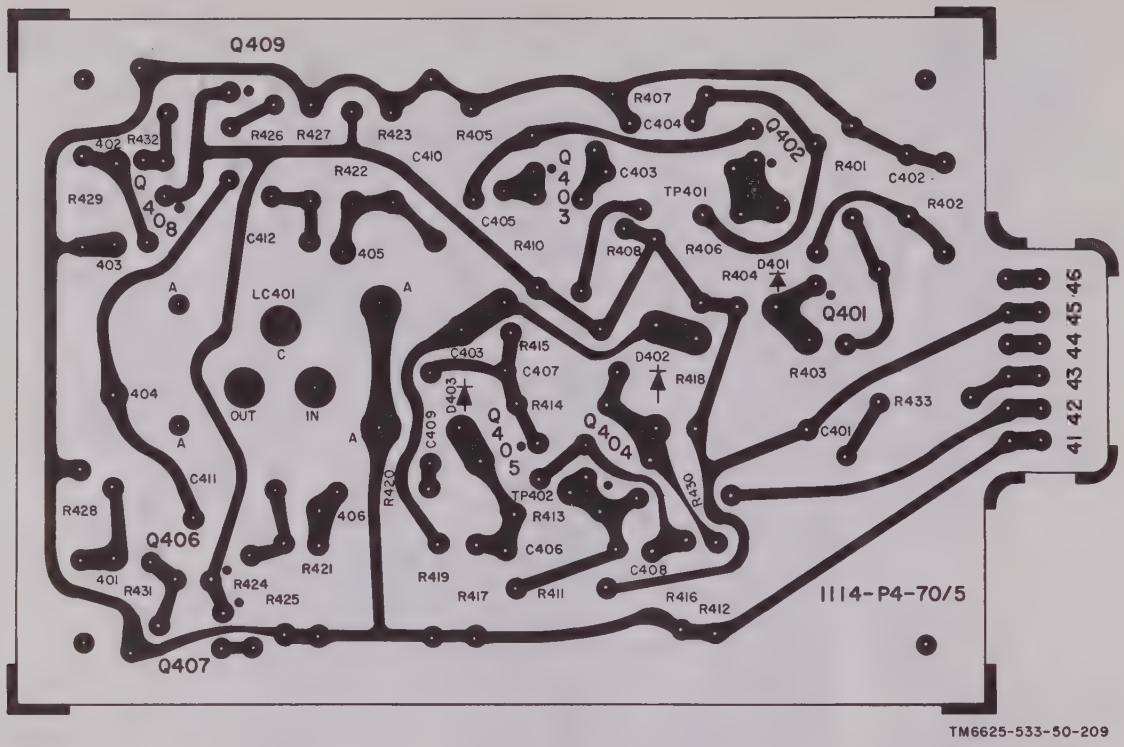
NOTES:

RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K=1000 OHMS M=1 MEGOHM
CAPACITANCE VALUES ONE AND OVER IN MICROMICROFARADS
LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED

⊘ SCREWDRIVER CONTROL

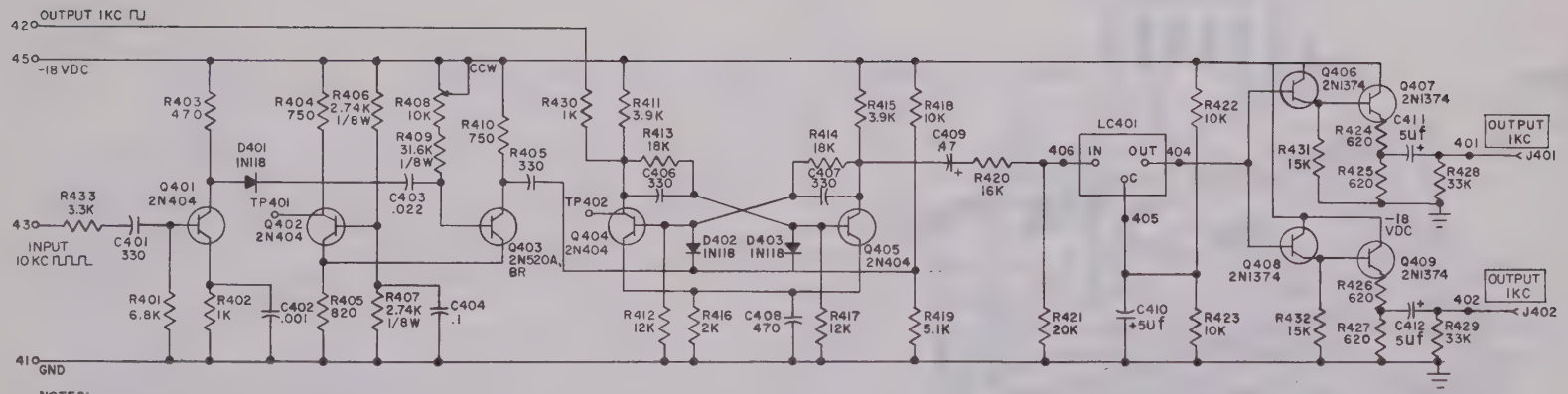
TM6625-533-50-203

Figure 2-72. Frequency Divider CV-1517/URM-18A, 1114-P3 plug-in unit, schematic diagram.



TM6625-533-50-209

Figure 2–73. Frequency Divider CV–1517/URM–18A, 1114-P4 plug-in unit, circuit board diagram.



NOTES:

RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K=1000 OHMS M= 1 MEGOHM
CAPACITANCE VALUES ONE & OVER IN MICRO-MICROFARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.
⊘ SCREWDRIVER CONTROL

TM6625-533-50-204

Figure 2–74. Frequency Divider CV–1517/URM–18A, 1114-P4 plug-in unit, schematic diagram.

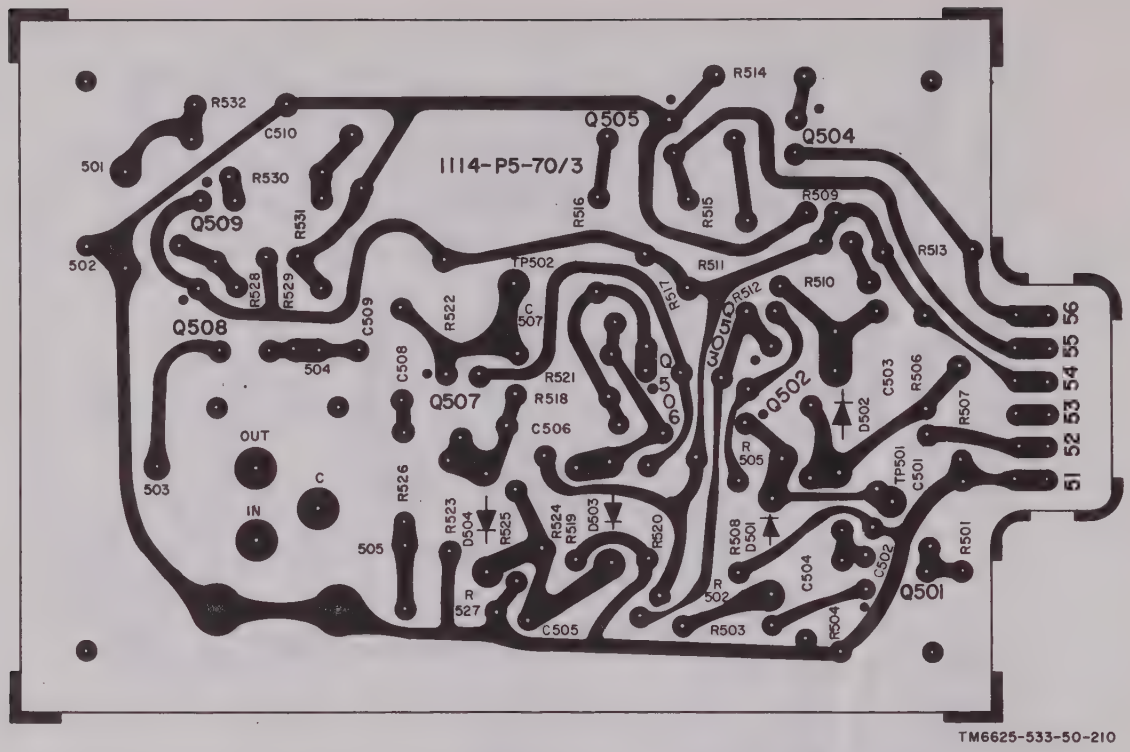
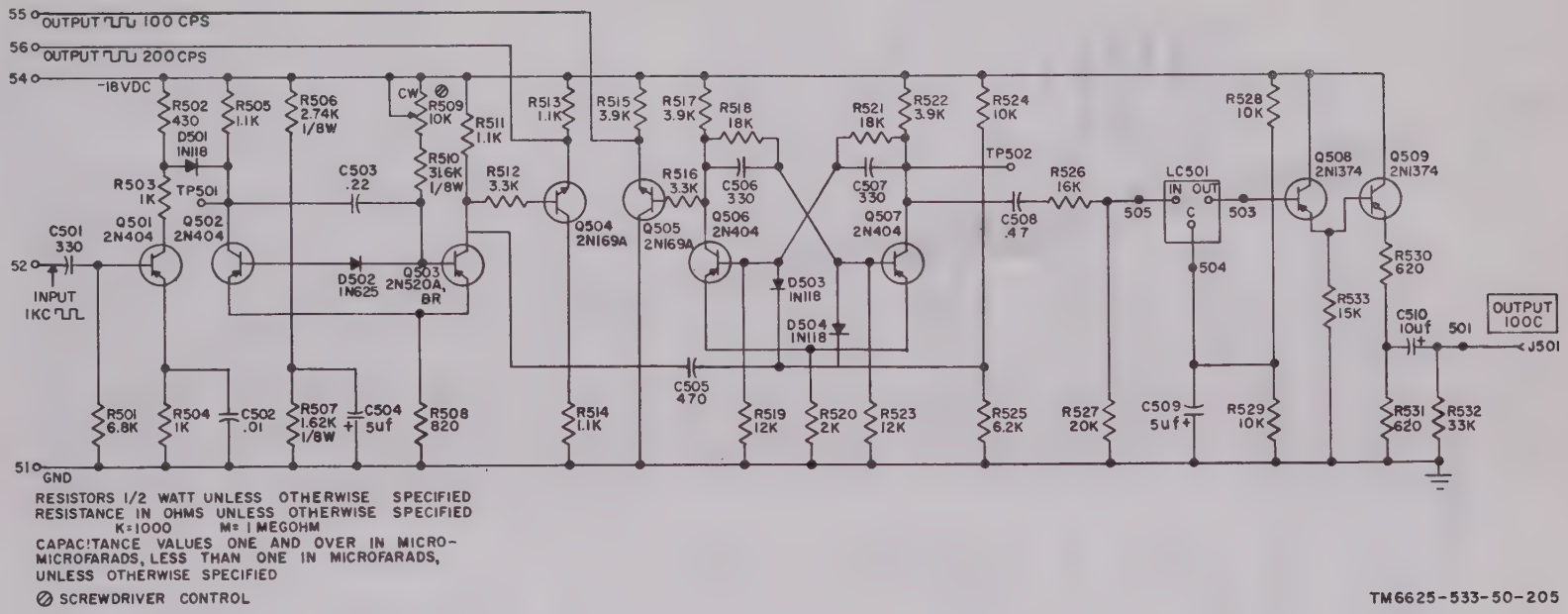


Figure 2–75. Frequency Divider CV–1517/URM–18A, 1114-P5 plug-in unit, circuit board diagram.



RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K=1000 M= 1 MEGOHM
CAPACITANCE VALUES ONE AND OVER IN MICROMICROFARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED
⊘ SCREWDRIVER CONTROL

TM6625-533-50-205

Figure 2–76. Frequency Divider CV–1517/URM–18A, 1114-P5 plug-in unit, schematic diagram.

CHAPTER 3

REPAIRS AND ALIGNMENT

Section I. REPAIRS

3–1. General Parts Replacement Techniques

Most of the parts of Calibrator Set Frequency AN/URM–18A can be reached and replaced without special procedures. The following precautions apply specifically to the calibrator set.

Caution: **Do not attempt any repairs of the frequency calibrator without having a full understanding of paragraphs 14, 15, and 16, TM 11–6625–345–12.**

a. When soldering connections to the feedthrough capacitors, be careful to prevent the glass portion of the capacitor from cracking when the center conductor gets hot. Grasp the central lead with pliers between the glass bead and the eye of the terminal before applying heat.

b. When replacing items such as switches, meters, controls, or tube sockets, disconnect one wire at a time, and tag each lead to identify its connection. This will make wiring the new part easier.

c. When performing repairs on the units, caution should be taken so as not to disturb the setting of any of the internal adjustments.

d. When replacing items in units which contain transistorized circuits, use a soldering iron with a 25-watt maximum capacity. If the iron must be used with ac, use an isolating transformer between the iron and the line. Do *not* use a soldering gun; damaging voltages can be induced in components.

e. When soldering transistor leads, solder quickly; wherever wiring permits, use a heat sink (such as long-nose pliers) between the soldered joint and the transistor. Use approximately the same length and dress of transistor leads as used originally.

f. Aid will be required to remove a unit from a rack, unless that portion of the rack below the unit being removed is occupied by another unit or a blank panel.

3–2. Replacement of Frequency Calibrator Crystal Oven Assembly Components

Caution: **Do not remove the power to the frequency calibrator unless absolutely necessary. Have a full understanding of paragraphs 14, 15, and 16, TM 11–6625–345–12 before attempting replacement of any frequency calibrator components.**

a. To gain access to parts in crystal oven assembly remove the front panel, disconnect the power cable from P501 (fig. 2–2), and proceed as follows:

(1) Remove Standard Frequency Oscillator O–1106/URM–18A from calibrator group rack.
(2) Remove the outer case from the frequency calibrator.
(3) Remove the left side of chassis.
(4) Disconnect plug P503 (fig. 2–4).
(5) Remove the four screws holding the crystal oven assembly to the front panel.
(6) Remove the crystal oven assembly from the main chassis.
(7) Remove the four nuts holding the outer cover (fig. 2–11).
(8) Carefully slip off the outer cover.
(9) Remove P601 from JS601.
(10) Loosen the clamping ring.
(11) Hold the crystal oven assembly in a vertical position with the tuning mechanism at the bottom.
(12) Carefully lift the outer oven straight upward.

(13) With the crystal oven assembly in a vertical position, lift off the vacuum bottle.

(14) While holding the crystal oven assembly firmly, remove the cylindrical shield. At this point, all components of the inner oven assembly are accessible.

b. To reassemble the crystal oven assembly, proceed as follows:

(1) Replace the cylindrical shield (fig. 2–11).
(2) Replace the vacuum bottle.
(3) Carefully slip the outer oven over the vacuum bottle.
(4) Position the outer oven so that J601 and P601 are in line.
(5) Position the clamping ring at the end of the outer oven.
(6) Tighten the clamping ring.
(7) Connect P601 to J601.
(8) Replace the outer cover.
(9) Replace the four nuts that secure the outer cover.
(10) Insert the crystal oven assembly into the main chassis and replace the four screws holding the crystal oven assembly to the front panel.
(11) Replace the chassis side.
(12) Insert the frequency calibrator into the case.
(13) Replace the frequency oscillator into the calibrator group rack.
(14) Follow the procedures in paragraph 16, TM 11–6625–345–12, to return power to the frequency calibrator.

3–3. Replacement of Oscilloscope Cathode-ray Tube

(figs. 2–53 and 2–54)

a. Removal. Remove the cathode-ray tube from Oscilloscope OS–16A/URM–18 as follows:

(1) Remove the oscilloscope from the meter group rack.
(2) Remove this cover from the oscilloscope.
(3) Short out high-voltage capacitors C31, C32, C33 and C34 (fig. 2–55) and note the relative position of the key on the tube socket.
(4) Loosen the ring clamp (fig. 2–53).
(5) Gently pull the knobs attached to the tube socket.
(6) Remove the tube socket.
(7) Remove the cathode-ray tube.

b. Replacement. Replace and reassemble the cathode-ray tube as follows:

(1) Insert the new cathode-ray tube, being careful that cap is aligned with face of tube.
(2) Replace the tube socket, checking to see that key is aligned properly. If necessary, rotate the socket and cathode ray tube, so that key of socket is in the same position as when removed.
(3) Operate equipment so that alignment of the cathode-ray tube can be checked with a horizontal line.
(4) Tighten the ring clamp.
(5) Replace the oscilloscope cover.
(6) Replace the oscilloscope in the meter group rack.

3–4. Replacement of Frequency Meter Section Tuning Mechanism

The removal and replacement of the frequency meter section tuning mechanism is the same for the FR–43A/URM–18, FR–44/URM–18, and FR–45A/URM–18; therefore, the following procedure shall apply to all three units.

a. Removal (figs. 2–33 and 2–34).

(1) Remove the frequency meter from the meter group rack.
(2) Remove the cover from the frequency meter.
(3) Rotate frequency meter RANGE switch to extreme counterclockwise position.
(4) Remove the frequency meter RANGE switch knob and frequency meter coarse control knob.
(5) Remove the shielded lead from holder.
(6) Unsolder the bus lead and short cable leads from their respective terminals.
(7) Remove tubes V2 and V3.
(8) Remove the three retaining screws that hold the frequency meter section

tuning mechanism to the bottom of the frequency meter chassis.

(9) Carefully remove the frequency meter section tuning mechanism from the frequency meter chassis; check to see that wiring or any part of the mechanism does not catch on another part.

(10) Remove the four screws holding the coil selector assembly cover.

(11) Remove the cover from the coil selector assembly.

(12) Remove the four screws holding the coil selector assembly to the frequency meter section tuning mechanism.

(13) Remove the coil assembly and retain the link chain.

Replacement and Reassembly.

(1) Position the coil selector assembly on the new frequency meter section tuning mechanism.

(2) Position the frequency meter RANGE dial so that the extreme counterclockwise indication will be seen in the range window.

(3) Position the link chain for range switching mechanism onto gears.

(4) Replace the four retaining screws holding the coil selector assembly to the frequency meter section tuning mechanism.

(5) Replace the coil selector assembly cover and the four cover-retaining screws.

(6) Insert wiring into the chassis hole, and position the frequency meter section tuning mechanism onto the frequency meter chassis, checking to see that the shafts go into their respective holes through the front panel.

(7) Replace the three retaining screws holding the frequency meter section tuning mechanism.

(8) Resolder the bus lead and short cable leads to their respective terminals.

(9) Reinstall the shielded lead in its holder.

(10) Replace V2 and V3.

(11) Replace the frequency meter cover.

(12) Replace the frequency meter into the meter group rack.

3–5. Replacement of Detector Section Tuning Mechanism

The removal and replacement of the detector section tuning mechanism is the same for the FR–43A/URM–18, FR–44/URM–18, and FR–45A/URM–18; therefore, the following procedure shall apply to all three units.

a. Removal (figs. 2–33 and 2–34).

(1) Remove the frequency meter from the meter group rack.

(2) Remove the cover from the frequency meter.

(3) Rotate the detector RANGE switch to its extreme counterclockwise position.

(4) Remove the detector RANGE switch knob and detector control knob.

(5) Remove the shielded lead, connected to the detector section tuning mechanism, from its holder.

(6) Unsolder the bus lead and short cable leads from their respective terminals.

(7) Remove tubes V7 and V8.

(8) Remove the three retaining screws that hold the detector section tuning mechanism to the bottom of the frequency meter chassis.

(9) Carefully remove the detector section tuning mechanism from the frequency meter chassis, checking to see that wiring or any part of the mechanism does not catch on another part.

(10) Remove the four screws holding the coil selector assembly cover.

(11) Remove the cover from the coil selector assembly.

(12) Remove the four screws holding the coil selector assembly to the detector section tuning mechanism.

(13) Remove the coil assembly, and retain the link chain.

b. Replacement and Reassembly.

(1) Position the coil selector assembly on the new detector section tuning mechanism.

(2) Position the detector RANGE dial so that the extreme counterclockwise

indication will be seen in the range window.

(3) Position the link chain for range switching mechanism onto gears.

(4) Replace the four retaining screws holding the coil selector assembly to the detector section tuning mechanism.

(5) Replace the coil selector assembly cover and four cover-retaining screws.

(6) Insert wiring into the chassis hole, and position the detector section tuning mechanism onto the frequency meter chassis, checking to see that the shafts go through the respective holes in the front panel.

(7) Replace the three retaining screws holding the detector section tuning mechanism.

(8) Resolder the bus lead and short cable leads to their respective terminals.

(9) Reinstall the shielded lead in holder.

(10) Replace V7 and V8.

(11) Replace the frequency meter cover.

(12) Replace the frequency meter into the meter group rack.

3–6. Disassembly of Frequency Calibrator Coarse Frequency Tuning Mechanism

(fig. 3–1)

Caution: **Do not remove power from the frequency calibrator unless absolutely necessary. Have a full understanding of paragraphs 14, 15, and 16, TM 11–6625–345–12, before attempting replacement of any frequency calibrator components.**

a. Disassemble the coarse frequency tuning mechanism as follows:

(1) Remove the crystal oven assembly from the main chassis (para 3–2*a* (1) through (6)).

(2) Loosen setscrews (8) on coupling (9) on the coarse frequency tuning mechanism side.

(3) Remove four screws (2) and washers (3). This permits removal of the coarse frequency tuning mechanism away from the backplate (32).

(4) Remove two stop bracket retaining screws (4) and washers (5).

(5) Remove stop bracket (6).

(6) Remove stop nut (7).

(7) Remove three screws (10) and washers (11).

(8) Remove bearing plate (12).

(9) Remove the two screws (13) which secure shaft nut (15).

(10) Remove shaft nut (15) and gear (17) assembly from the main frame.

(11) Remove shaft nut (15) from shaft (18).

(12) Loosen setscrew (16), and remove gear (17) from shaft (18).

(13) Loosen setscrew (19), and remove gear (20) and bushing (21).

(14) Remove screw (22) and washer (23).

(15) Remove retaining screw (24).

(16) Loosen setscrew (25).

(17) Remove counting dial (26).

(18) Loosen setscrew (27).

(19) Remove collar (28).

(20) Remove shaft (29).

(21) Remove nut (30) and washer (31).

(22) Remove backplate (32).

(23) Remove bearing (33).

(24) Remove three screws (34) and washers (35).

(25) Remove spacers (36) from front plate (37).

b. Reassemble the coarse frequency tuning mechanism as follows:

(1) Using three screws (34) and washers (35), attach three spacers (36) to front plate (37).

(2) Screw into the front plate bearing (33).

(3) Attach bearing (33) to front plate (37) using nut (30), washer (31), screw (22), and washer (23).

(4) Set counting dial (26) to a reading of zero-zero in the counterclockwise direction.

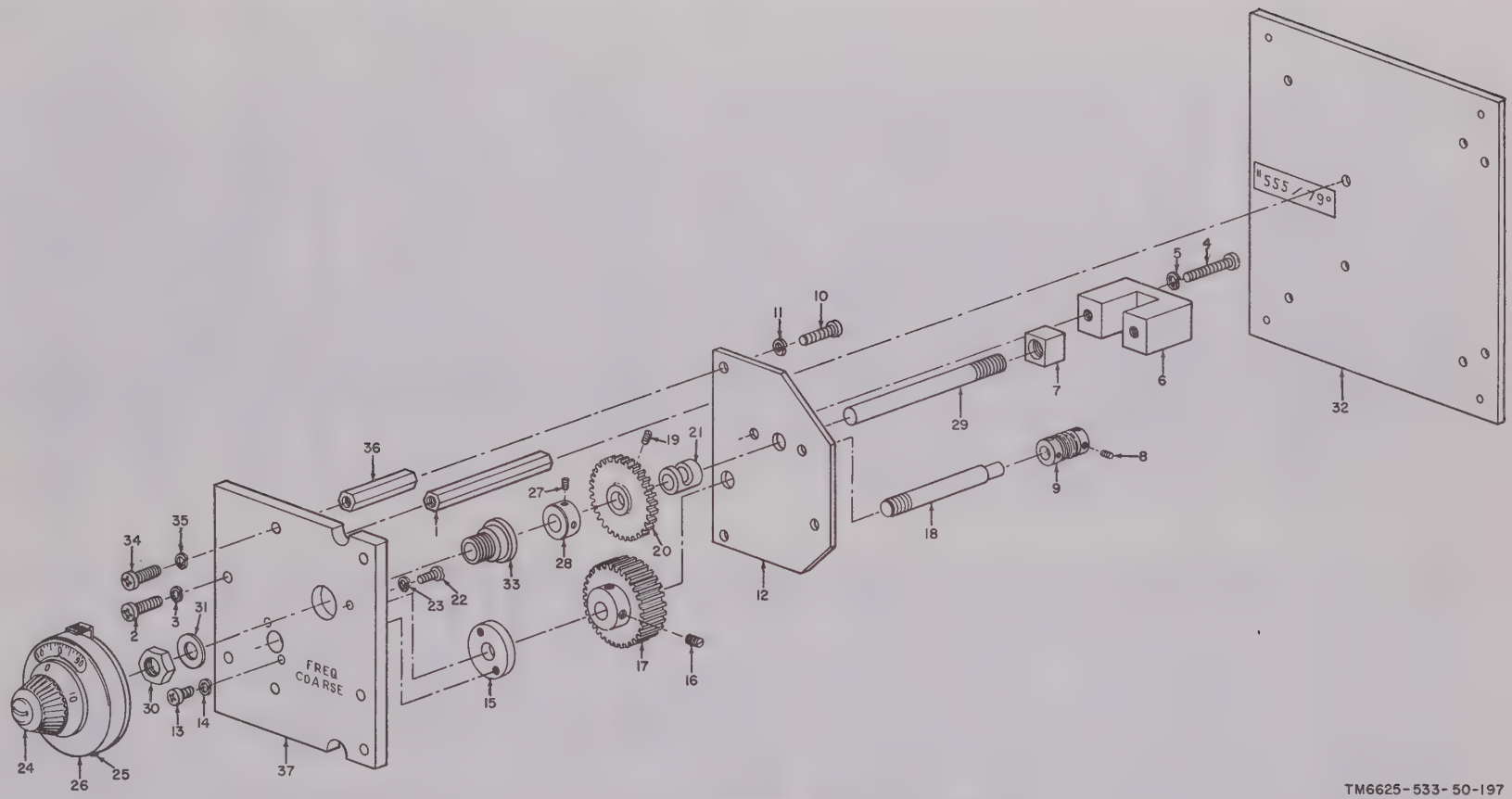
(5) Attach counting dial to the counting dial backplate (32), using screw (34), so that the indicating pointers are at the farthest distance from the engraving, FREQ. COARSE.

(6) Place collar (28) on the shaft (29). Locate the collar 1 inch from the end of the unthreaded portion of the shaft, then tighten setscrew (27).
(7) Insert the unthreaded portion of shaft (29) into bearing (33), and tighten setscrew (25).
(8) Insert bushing (21) into gear (20) so that the opening of the bushing is located directly below setscrew (19).
(9) Place gear (20) and bushing (21) onto shaft (29) so that the smooth gear face is located 35/64 of an inch away from the front plate (37).
(10) Thread shaft nut (15) onto shaft (18) so that the flat face of the shaft nut faces the unthreaded portion of the shaft. The assembly is positioned so that the shaft and the flanged end of the shaft nut are flush.
(11) Insert the shaft and shaft nut assembly into the front plate, and attach with retaining screws (13) and washers (14).
(12) Place gear (17) onto shaft (18) so that the setscrew (16) side of the gear is facing front plate (37).
(13) Position gear (17) on shaft (18) so that the flat surface of the gear is 7/8 of an inch from the front plate, and tighten setscrew (16).
(14) Place bearing plate (12) onto the assembly so that the shafts (18) and (29) and spacers (36) align to their respective holes.
(15) Using three screws (10) and washers (11) attach bearing plate (12) to spacers (36).
(16) Thread stop nut (7) onto shaft (29) so that the counterbored portion of the nut is toward bearing plate (12). Position stop nut (7) so that it is flush with the end of the shaft.
(17) Using two screws (4) and washers (5) attach stop bracket (6).
(18) Attach coupling (9) to shaft (18), and rotate coupling (9) to the extreme counterclockwise position.
(19) Place the coarse frequency tuning mechanism onto backplate (32) so that coupling (9) and spacers (1) are properly aligned.
(20) Attach the coarse frequency tuning assembly to the oven assembly using four screws (2) and washers (3).
(21) Tighten setscrew (8) on coupling (9).
(22) Replace the crystal oven assembly into the main chassis (para 3–2*b*(10) through (14)).

3–7. Disassembly of Signal Generator Main Tuning Assembly
(fig. 4–3)

a. Disassemble the main tuning assembly as follows:

(1) Remove light pipes (4) by removing screw (2), washers (3), and light pipe clamp (1).
(2) Unsolder all wiring to capacitor (5), and mark it for identification.
(3) Remove capacitor (5) by removing screws (6) and washers (7) from bracket (8).
(4) Remove bracket (8) by removing screw (9) and washers (10).
(5) Remove bracket (11) by removing screws (12), washers (13), and terminal (14).
(6) Remove capacitor (15) by removing screws (16) and washers (17).
(7) Remove plate (18) by removing screws (19) and washers (20).
(8) Remove mask (21) by removing screws (22), nuts (23), and washers (24).
(9) Remove brackets (25) by removing screws (26) and washers (27).
(10) Remove retaining ring (28) and washer (29).
(11) Loosen setscrew (31), and remove dial (30).
(12) Remove bushing (32) and gear (36) by removing screw (33), nut (34), and washer (35).
(13) Remove washers (37) and (38).
(14) Remove guide (39) and plunger (42) by removing screws (40) and washers (41).
(15) Remove attached spring (43) from



1	Spacer	11	Washer	20	Gear	29	Shaft
2	Screw	12	Plate, bearing	21	Bushing	30	Nut
3	Washer	13	Screw	22	Screw	31	Washer
4	Screw	14	Washer	23	Washer	32	Backplate
5	Washer	15	Shaft nut	24	Screw, retaining	33	Bearing
6	Bracket, stop	16	Setscrew	25	Setscrew	34	Screw
7	Nut, stop	17	Gear	26	Dial, counting	35	Washer
8	Setscrew	18	Shaft	27	Setscrew	36	Spacer
9	Coupling	19	Setscrew	28	Collar	37	Front plate
10	Screw						

Figure 3-1 Standard Frequency Oscillator O-1106/URM-18A coarse frequency turning mechanism, exploded view.

guide (39) by removing screw (44) and washer (45).

(16) Remove plate (46) by removing screws (47) and washers (48) and (49).

(17) Remove shaft (50) by removing nut (51) and washers (52) and (53).

(18) Loosen setscrews (55), and remove collar (54).

(19) Remove gear (60) and shaft (61).

(20) Remove bushing (59) by removing nut (56) and washers (57) and (58).

(21) Loosen setscrews (63), and remove spur and worm gear (62).

(22) Remove dial (81) by removing screws (80) and plate (79).

(23) Loosen setscrews (83), and remove gear (82) by removing screw (84) and nut (85).

(24) Remove tension spring arm (64) by removing screws (65), washers (66), and spacer (69).

(25) Remove adjusting screw (67) and lock nut (68) from tension spring arm (64).

(26) Remove tension spring (70), bearing spring (73), and shims (77) by removing screws (75) and washers (76).

(27) Remove worm shaft (91).

(28) Remove nut (71), spacer (72), and bearing holder (74), which contains ball bearing (78) from worm shaft (91).

(29) Remove bearing clamp (86) by removing screws (87) and washers (88).

(30) Remove bearing block (90) and ball bearing (89) by removing screws (90B) and washers (90A).

(31) Remove cover plate (92) by removing screws (93) and washers (94).

(32) Loosen setscrews (96), and remove gear assembly (95) and washer (97).

(33) Loosen setscrew (99), and remove collar (98) and washer (100).

(34) Remove shaft (105).

(35) Remove nut (101) and washers (102) and (103).

(36) Remove bushing (104).

b. The remaining parts consist of the stator and rotor plates and their supporting parts attached to the frame (138).

c. Reassemble the main tuning assembly as follows:

(1) Attach bushing (104) to main frame assembly, using nut (101) and washers (102) and (103).

(2) Insert shaft (105) through bushing (104).

(3) Place washer (100) and collar (98) onto shaft (105) from the inside of the frame assembly.

(4) Position collar (98) so that the rear face of the collar is flush with the end of shaft (105), and tighten setscrews (99).

(5) Place washer (97) and gear assembly (95) onto shaft (105), located on the outside of the frame assembly.

(6) Take up end play of shaft (105) before tightening setscrew (96) on gear assembly (95).

(7) Attach cover plate (92), using screws (93) and washers (94).

(8) Insert ball bearing (89) into clamp (86), and attach bearing block (90), using screws (90B) and washers (90A).

(9) Attach bearing holder (74), containing ball bearing (78) spacer (72) and nut (71), to worm shaft (91).

(10) Insert worm shaft (91) into ball bearing (89).

(11) Attach clamp (86) to frame (138), using washer (88) and screws (87).

(12) Attach tension spring (70) and bearing spring (73), using shims (77), screws (75), and washers (76).

(13) Attach adjusting screw (67) and locknut (68) to tension spring arm (64).

(14) Attach tension spring arm (64), spacer (69), and bearing spring (73) to frame (138) with washers (66) and screws (65).

(15) Place gear (82), with screw (84) and nut (85) attached, on worm shaft (91) so that the side with the setscrew is away from the main frame

assembly. Check to see that gear (82) and gear assembly (95) mesh so that gear assembly (95) will apply tension by at least one tooth.

(16) Tighten setscrew (83).

(17) Rotate shaft (105) to check that gear (82) and gear assembly (95) run without binding or extreme high spots. If difficulty is incurred remove gear (82), rotate shaft (105) to some degree, then reattach gear (82). Repeat this process until the best running condition is obtained.

(18) Lubricate gear (82) and gear assembly (95) with Grease, Aircraft and Instrument (GL) (FSN 9150–576–4262).

(19) Insert spur and worm gear (62) over rotor shaft, checking for proper mating with worm shaft (91). It may be necessary to back off adjusting screw (67).

(20) Tighten setscrew (63), and apply lubricant ((18) above) to the worm shaft.

(21) Attach bushing (59) to plate (46), using nut (56) and washers (57) and (58), and to shaft (50), using nut (51) and washers (52) and (53).

(22) Insert gear (60) and shaft (61) into bushing (59), and secure collar (54) on end of shaft (61) with setscrews (55).

(23) Attach plate (46) to main frame (138), using screws (47) and washers (48) and (49). Check to see that gears (60) and (62) mesh properly. Lubricate gears as in (18) above.

(24) Attach spring (43) to guide (39), using screw (44) and washers (45).

(25) Apply a small amount of lubricant ((18) above) to both sides of plunger (42).

(26) Attach plunger (42) and guide (39) to plate (46), using screws (40) and washers (41). Check to see that spring (43) applies tension to plunger (42) to position the plunger away from gear (82).

(27) Attach brackets (26), using screws (26) and washers (27).

(28) Rotate shaft (105) until the rotor plates are completely meshed with C19 and the stator plates are located in the rear of the main frame assembly.

(29) Rotate shaft (105) counterclockwise so that gear (82) rotates 2½ turns. At this point, plunger (42) should line up with screw (84) on gear (82). It may be necessary to loosen setscrews (83), and, while holding spur and worm gear (62) to prevent it from moving, rotate gear (82) until screw (84) lines up with plunger (42). Then, tighten setscrews (83).

(30) Insert washers (37) and (38) over shaft (50).

(31) Insert bushing (32) and gear (36) over shaft (50) with gear (36) meshing with spur and worm gear (62). Position this assembly without moving the spur and worm gear, so that the pin in gear (36) will push plunger (42) to a point where it will just make contact with screw (84) but still permit rotation of gear (36). With one additional rotation of gear (36), plunger (42) will extend to a point to cause screw (84) to hit plunger (42) and stop.

(32) Rotate shaft (105) clockwise until the rotor plates are fully meshed, and place dial (30) washer (29) and then retaining ring (28) onto bushing (32).

(33) Attach mask (21) to brackets (25), using screws (22), nuts (23), and washers (24).

(34) Rotate dial (30) until the isolated division line to the left of zero scale indication is aligned with the hairline of mask (21), and then tighten setscrew (31) on dial (30).

(35) Attach dial (81) to gear (82), using plate (79) and screws (80). Position the dial so that zero indication is aligned with the hairline of mask (21), and then tighten screws (80).

(36) Attach capacitor C22 (15) to plate (18), using screws (16) and washers (17).

(37) Attach plate (18) to main frame (138) assembly, using screws (19) and washers (20).

(38) Attach capacitor C21 (5) to bracket (8), using screws (6) and washers (7).

(39) Attach bracket (8) to bracket (11), using screws (9) and washers (10).

(40) Attach bracket (11) to main frame (138) assembly, using screws (12), washers (13), and terminal (14).

(41) Resolder all connections to capacitors C21 (5) and C22 (15).

(42) Attach light pipes (4) to bracket (11) using screws (2), washers (3), and light pipe clamp (1).

Section II. ALIGNMENT

3–8. Alignment of Standard Frequency Oscillator O–1106/URM–18A

a. Test Equipment Required. The following test equipment is required for alignment of the O–1106/URM–18A:

(1) Standard Signal Generator, General Radio Type 1001-A.
(2) Voltmeter, Electronic AN/USM–98.
(3) Unit Time/Frequency Calibrator, General Radio Type 1213–D.
(4) Stopwatch.

b. Oscillator Amplifier Alignment Procedure.

(1) Remove V201 (fig. 2–9) and the shield from V505 (fig. 2–7).
(2) Unsolder the existing wire from AT–31 (fig. 2–10).
(3) Using a Unit Time/Frequency Calibrator, General Radio Type 1213–D, calibrate the Standard Signal Generator, General Radio Type 1001–A, to exactly 5MC.
(4) Set the Standard Signal Generator General Radio Type 1001–A, with the attenuator, to minimum indication on the X10MV range.
(5) Connect the attenuator output to terminal AT–31 with a shielded cable less than 3 feet long.
(6) Turn METER SWITCH S503 to AGC and the POWER switch to ON.
(7) Adjust the Standard Signal Generator, General Radio Type 1001–A, output until meter M501 indicates a deflection.
(8) Adjust variable inductors L201 and L202 for maximum meter deflection (fig. 2–3).
(9) Adjust the output of the Standard Signal Generator, General Radio Type 1001–A, so as not to exceed 15UA on meter M501.
(10) Readjust L201 and L202 for maximum meter deflection.
(11) Adjust the output of the Standard Signal Generator, General Radio Type 1001–A, so that Meter M501 will indicate 10UA.
(12) The attenuator reading on the Standard Signal Generator, General Radio Type 1001–A, must indicate less than 5MV.
(13) Set the METER SWITCH to OUTPUT.
(14) Tune transformer T201 for maximum indication on Meter M501.
(15) Remove the Standard Signal Generator, General Radio Type 1001–A, from AT31.
(16) Move the POWER switch to STAND-BY ONLY.
(17) Resolder the lead onto AT–31.
(18) Install V201 and the shield to V505.

c. Inner and Outer Oven Adjustment. The following adjustments are to be made only after the frequency calibrator has been operating for at least 24 hours.

(1) While the frequency calibrator is energized, slide the unit out of its case until the inner and outer oven temperature controls are exposed.

(2) Position the METER SWITCH to OVEN TEMPS-INNER.

(3) Adjust INNER OVEN TEMP CAL R543 (fig. 2–6) for a reading of 25UA on meter M501 (fig. 2–1).

(4) Position the METER SWITCH to OVEN TEMPS-OUTER.

(5) Adjust OUTER OVEN TEMP CAL R536 (fig. 2–6) for a reading of 28.5UA on meter M501 (fig. 2–1).

(6) Using a stopwatch, measure several cycles of inner oven cycling lamp DS502 (fig. 2–1). Determine the average *on* time and *off* time in seconds. The ratio of the *on* to *off* time will vary from 1 to 3 to 1 to 6. The lower ratios are considered more desirable. A ratio of over 1 to 6 is an indication of a maladjusted oven temperature control.

d. Dc Power Supply Adjustment.

(1) Remove the frequency calibrator from its case.

(2) Connect the AN/USM–98 to AT–61 (fig. 2–7) on the rear of the power supply.

(3) Energize the frequency calibrator.

(4) Adjust control R528 (fig. 2–6) for a reading of 6.6 volts dc.

(5) Vary the line voltage from 105 to 125 volts. The heater voltage must not change more than 0.5 volts.

3–9. Test Equipment and Special Tools Required for Alignment of Frequency Divider CV–1517/URM–18A

The following test equipment is required for the alignment of Frequency Divided CV–1517/URM–18A:

a. Audio Oscillator TS–382F/U.

b. Oscilloscope AN/USM–140A.

c. Voltmeter, Meter ME–30A/U.

d. Frequency Meter AN/USM–26.

e. Transformer, Variable Power CN–16/U.

f. Voltmeter, Electronic AN/USM–98.

g. Extension Cable, General Radio Type 1114-P9 (extension cable).

3–10. General Procedures for Alignment and Adjustment of Frequency Divider Plug-In Units

In the following alignment and adjustment procedures concerning the plug-in units 1114-P1 through 1114-P5 (fig. 2–20), the frequency divider shall be used as a test jig. In each case, the plug-in unit to be adjusted or aligned shall be removed from the main chassis. The extension cable (fig. 2–57) will then be connected from the plug-in unit to the main chassis. To remove a plug-in unit, remove the extreme top and extreme bottom screws, and pull the plug-in unit away from the chassis.

3–11. Alignment of Frequency Divider 1114-P1 Plug-In Unit

a. Remove 1114-P1 from the main chassis, and connect a 5-mc, 1-volt signal to 5MC INPUT J102.

b. Connect a 50-ohm termination to 1MC OUTPUT J101.

c. Connect the AN/USM–140R to TP101 (fig. 2–21).

d. Using a fiberglass screwdriver, adjust capacitors C109 and C103 for a maximum undistorted 4-mc sine wave.

Note. The signal at TP101 is a 4-mc sine wave, approximately 2 volts peak-to-peak (pp), and has a 1-mc envelope, approximately 0.2 volt peak-to-peak. Large variation in the amplitude over longer periods of time (10 to 20 usec) are due to spurious oscillations in the divider system and must be eliminated by proper tuning of C109 and C103.

e. Remove the 50-ohm termination from J101.

f. Connect the AN/USM–140A to J101.

g. Adjust T102 for maximum undistorted sine wave output. This output must be greater than 2.7 volts pp.

h. Remove the AN/USM–140A from J101, and reconnect the 50-ohm termination.

i. Connect the AN/USM–140A to terminal 16.

j. Adjust transformer T101 for maximum output. The value of this output must be a sine wave greater than 1.2 volts pp.

k. Remove the AN/USM–140A from terminal 16 and connect it to TP101.

l. Adjust the 5-mc input to 0.25 volt.

m. Readjust C109 and C103 for an undistorted output.

n. Connect the AN/USM–140A to J101 (rear of connector).

o. Remove 50-ohm termination J101 and the input signal from J102. No output should be observed on the AN/USM–140A (no oscillation).

p. Reconnect the 50-ohm termination to J101.

q. Adjust the 5-mc generator to minimum output and connect to J102.

r. Gradually increase the output of the 5-mc generator. The plug-in unit must begin to oscillate with less than 0.2-volt input and saturate (attain maximum amplitude at J101) with less than 0.35 volts.

Note. Failure to oscillate with less than 0.2 volt can be corrected by detuning C109 slightly in the direction of more capacitance and retuning C103. Failure to saturate requires retuning of C103 and C109 with the input signal at a minimum. Critical tuning can be corrected by replacing C103.

s. Remove the 50-ohm termination from J101.

t. Use the AN/USM–140A to observe the output at TP101 and J101. If retuning is necessary, repeat the procedures in *l* thru *r* above.

u. Adjust the 5-mc signal to 1 volt.

v. Connect the AN/USM–140A to J101.

w. Adjust T102 for maximum undistorted output. The output must be greater than 2.7 volts pp.

x. Connect the AN/USM–140A to terminal 16.

y. Adjust T101 for maximum undistorted output. The output must be greater than 1.2 volts pp.

z. Disconnect the equipment, remove the extension cable, replace plug-in unit 1114–P1 in the main chassis, and secure 1115-P1 in place with two screws.

3–12. Alignment of Frequency Divider 1114-P2 Plug-In Unit

(fig. 2–20)

a. Remove plug-in unit 1114-P2 from the main chassis and connect a 5-mc signal, at 1 volt, to J102 (1114-P1) INPUT 5MC.

b. Connect an AN/USM–140A to TP201 (fig. 2–22).

c. Adjust R208 so that the negative 7- to 10-volt pulse starts at the fourth positive pulse and reaches maximum amplitude at the fifth positive pulse.

d. Disconnect and reconnect the input signal at J102 (1114-P1). The AN/USM–140A presentation will stop and start without any change in the scope pattern.

e. Connect a 50-ohm termination to 100KC OUTPUT ∼ J201.

f. Connect the AN/USM–140A to the rear of J201.

g. Adjust L203 and T201 for maximum undistorted 100-kc sine wave. The output must be greater than 2.7 volts pp.

h. Disconnect the test equipment, remove the extension cable, replace plug-in unit 1114-P2 in the main chassis, and secure 1114-P2 in place with two screws.

3–13. Alignment of Frequency Divider 1114-P3 Plug-In Unit

(fig. 2–20)

a. Remove plug-in unit 1114-P3 from the main chassis (para 3-10) and connect a 5-mc signal at 1 volt to J102 (1114-P1)

b. Connect an AN/USM–140A to TP301 (fig. 2–23).

c. Adjust R308 so that the negative 7- to 10-volt pulse starts at the fourth positive pulse and reaches maximum amplitude at the fifth positive pulse.

d. Disconnect and reconnect the input signal at J102 (1114-P1). The AN/USM–140A presentation will stop and start without any change in the scope pattern.

e. Disconnect the test equipment, remove the extension cable, replace plug-in unit 1114-P3 in the main chassis, and secure 1114-P3 in place with two screws.

3–14. Alignment of Frequency Divider 1114-P4 Plug-In Unit

(fig. 2–20)

a. Remove plug-in unit 1114-P4 from the main chassis, and connect a 5-mc signal, at 1 volt, to J102 (1114-P1).

b. Adjust the AN/USM–140A for a 50-usec/cm sweep, and a 5-volt/cm vertical sensitivity. Connect the AN/USM–140A to TP401 (fig. 2–24).

c. Adjust R408 so that the negative 7- to 10-volt pulse starts at the fourth positive pulse and reaches maximum amplitude at the fifth positive pulse.

d. Disconnect and reconnect the input signal at J102 (1114-P1). The AN/USM–140A presentation will stop and start without any change in the scope pattern.

e. Disconnect the test equipment, remove the extension cable, replace plug-in unit 1114-P4 in the main chassis, and secure 1114-P4 in place with two screws.

3–15. Alignment of Frequency Divider 1114-P5 Plug-In Unit
(fig. 2–20)

a. Remove plug-in unit 1114-P5 from the main chassis, and connect a 5-mc signal at 1 volt, to J102 (1114-P1).

b. Adjust the AN/USM–140A for a 500-usec/cm sweep, with a 5-volt/cm vertical sensitivity.

c. Connect the AN/USM–140A to TP501 (fig. 2–25).

d. Adjust R509 so that the negative 7- to 10-volt pulse starts at the fourth positive pulse and reaches maximum amplitude at the fifth positive pulse.

e. Disconnect and reconnect the input signal at J102 (1114-P1). The AN/USM–140A presentation will stop and start without any change in the scope pattern.

f. Disconnect the test equipment, remove the extension cable, replace plug-in unit 1114-P5 in the main chassis, and secure 1114-P5 in place with two screws.

3–16. Adjustment of Frequency Divider Power Supply Regulator
(fig. 2–19)

a. Connect a CN–16/U between the frequency divider power cable and the power outlet strip.

b. Connect an AN/USM–98 to terminal AT801 (fig. 2–26) and ground.

c. Adjust the CN–16/U 115 volts ac; energize the equipment.

d. Adjust R802 (fig. 2–26) for exactly −18.0 volts cc on the AN/USM–98.

e. Vary the CN–16/U from 100 volts to 130 volts; the −18.0 volts must change less than 0.05 volt.

3–17. Alignment of Frequency Divider Pulse Shaper
(fig. 2–19)

a. Turn the DRIVING FREQ switch to 1MC position.

b. Connect a 1-mc signal at 0.3 volt to J203 on 1114-P2.

c. Connect the AN/USM–140A to AT904 (fig. 2–27).

d. Adjust R906 for a 1-mc symmertical square wave, 6 to 7 volts pp.

e. Reduce the 1-mc input signal to a point where the pulse shaper just fails. Readjust R906 for proper operation at the lowest possible input signal level. The input signal must be less than 0.3 volt.

f. Turn the DRIVING FREQ switch (fig. 2–19) to the 100KC position.

g. Vary the input signal level from 0.4 to 1.5 volts; the pulse shaper output must not fail short of the range. If failure occurs, readjust R906 slightly, and repeat the procedures in *a* through *e* above.

3–18. Test Equipment and Special Tools Required for Alignment of Frequency Multiplier CV–1518/URM–18A

The following test equipment is required for the alignment of Frequency Multiplier CV–1518/URM–18A:

a. Signal Generator, General Radio Type 1001A.

b. Electronic Counter, Hewlett-Packard Type HP524D (electronic counter).

c. Voltmeter Electronic AN/USM–98.

d. Bridge Oscillator, General Radio Type 1330–A (bridge oscillator).

e. Distortion and Noise Meter, General Radio Type 1932–A (distortion and noise meter).

f. Transformer, Variable Power CN–16/U.

g. Grid-Dip Meter, Measurement Corp. Model 59-LF (grid dip meter).

h. 50-ohm termination.

3–19. Preliminary Frequency Multiplier Adjustments

a. Power Supply Adjustments.

(1) Connect a CN–16/U between the power input to the frequency multiplier and a primary power source.

(2) Connect the AN/USM–98 between C309 (fig. 2–14) and ground to measure dc volts.

(3) Adjust the CN–16/U for 115 volts ac, and energize the frequency multiplier.

(4) Adjust R508 (fig. 2–15) for a 200-volt dc indication on the AN/USM–98.

b. Tuned Circuit Adjustments. Use the grid-dip meter to perform the adjustments listed in the following chart. All adjustments are to be made for maximum indication on the grid-dip meter.

Grid-dip meter frequency	Couple signal to inductor	Adjust capacitor
2 mc	L200	C202
10 mc	L201	C206
10 mc	L220	C220
10 mc	L261	C263
20 mc	L300	C303
100 mc	L301	C305
100 mc	L320	C320
100 mc	L344	C350
100 mc	L343	C346
100 mc	L360	C364
100 mc	L362	C369

3–20. Alignment of Frequency Multiplier 1-Mc to 10-Mc Circuit

a. Alignment of 1-Mc to 10-Mc Circuit.

(1) Connect a 1-mc signal at 1 volt to J1 STD INPUT (fig. 2–14) and to the EXT FREQ STD input jack on an electronic counter.

(2) Connect meter M501 (fig. 2–14) to phase detector J200.

(3) Turn S200 (fig. 2–14) to TEST MULT.

(4) Adjust C202, C206, and C220 (fig. 2–17) in the order stated, for a maximum reading on meter M501.

(5) Turn S200 to TEST OSC.

(6) Adjust coarse level adjustment C252 and fine level adjustment C240 for a 30-ua reading on meter M501.

(7) Adjust C249 and C248 for a 10-mc, ±40-cycle indication on the electronic counter.

(8) Repeat the procedures given in (4) through (7) above.

(9) Turn S200 to USE.

(10) Adjust C248 for a 42-ua reading on meter M501. The electronic counter must indicate 10 mc ±1 cycle.

(11) Turn S200 to TEST MULT, and check meter M501 for a 30-ua reading. If necessary, repeat the procedures in (5) through (8) above. Check to see that M501 reads 30 ua and that the electronic counter indicates 10 mc ±40 cycles. If necessary, repeat the procedures given in (5) through (8) above, but do not disturb the setting of C248.

(12) Turn S200 to USE, and check to see that meter M501 indicates 42 ua and the electronic counter indicates 10 mc ±1 cycle.

(13) Adjust C248 slowly until meter M501 reads 42 ua ±10 ua, checking to see that the bridge oscillator is locked at 10 mc. The electronic counter must continually indicate 10 mc ±1 cycle over the entire tuning range of C248.

(14) Reset C248 for a 42-ua indication on meter M501.

(15) Remove the electronic counter from 10MC OUTPUT J201.

(16) Connect a 50-ohm termination to 10MC OUTPUT connector J201, (fig. 2–13).

(17) Adjust the AN/USM–98 to measure ac volts, and connect it across the 50-ohm termination.

(18) Adjust C263 and C267, in this order, for a maximum reading on the AN/USM–98. The final reading should be 1-volt minimum.

b. Alignment of 10-Mc Phase Detector.

(1) Remove the shield covering AT-222.

(2) Adjust the AN/USM–98 for zero balance on both dc positions, and apply the AN/USM–98 10MEG terminals between AT-222 and ground.

(3) Turn S200 (fig. 2–14) to TEST OSC.

(4) Adjust C221 for maximum indication on the AN/USM–98.

(5) Turn S200 to TEST MULT.

(6) Adjust C221 for maximum indication on the AN/USM–98.

(7) Turn S200 to TEST OSC.

(8) Adjust L220 for a zero reading on the AN/USM–98.

(9) Repeat the procedures given in (3) through (8) above until a zero indication on the AN/USM–98 is achieved for both TEST positions of S200.

(10) Turn S200 to TEST MULT.

(11) Disconnect the 1-mc signal cable at J3, and connect a 1-mc output of the test equipment bridge oscillator to J3.

(12) Adjust the bridge oscillator frequency control for a maximum indication on meter M501.

(13) Adjust the bridge oscillator output control for a reading of 30 ua on meter M501.

(14) Set the bridge oscillator modulation controls to internal 400 cycles at LOW % MOD.

(15) Using a distortion and noise meter, adjust R221 for a minimum noise reading.

(16) Repeat the procedures given in (5) through (13) above.

c. Adjustment of 10-Mc Lock Range. To perform the 10-mc lock range adjustment, proceed as follows:

(1) Turn S200 (fig. 2–14) to USE.

(2) Adjust C248 slowly clockwise until meter M501 indicates a discontinuous rate of change and the electronic counter no longer indicates 10 mc ±1 cycle.

(3) Turn S200 to TEST OSC, and check to see that the electronic counter indicates at least 170 cycles greater than 10 mc.

(4) Turn S200 to USE.

(5) Adjust C248 slowly counterclockwise until meter M501 indicates a sharp jump and then tracks smoothly. The electronic counter must indicate 10 mc ±1 cycle.

(6) Adjust C248 slowly counterclockwise until the bridge oscillator unlocks, the meter M501 reading changes sharply, and the electronic counter does not read within 1 cycle of 10 mc.

(7) Turn S200 to TEST OSC. The electronic counter must indicate at least 170 cycles less than 10 mc.

(8) Turn S200 to USE.

(9) Adjust C248 slowly clockwise until meter M501 reads 42 ua; the electronic counter must indicate 10 mc ±1 cycle. If the setting of C248 is now greatly off center, the capacitance of C256 (fig. 2–17) may be replaced by an increased or decreased value, whichever is necessary, to the next standard value.

3–21. Alignment of Frequency Multiplier 10-Mc to 100-Mc Circuit

a. Alignment of 10-Mc to 100-Mc Circuit.

(1) Connect a 1-mc signal, at 1 volt, to J1 STD INPUT and to the EXT FREQ STD input jack on an electronic counter.

(2) Connect meter M501 to phase detector J300.

(3) Connect the 100MC OUTPUT connector J301 (fig. 2–13) to the HP525A or HP525B Frequency Converter installed in the electronic counter. The HP525A has a mixing frequency of 90 mc; the HP525B has a mixing frequency of 110 mc.

(4) Turn S300 (fig. 2–14) to TEST MULT.

(5) Adjust C303, C305, and C320 in the order stated, for a maximum indication on meter M501. Readjust C251, 10-mc section, if necessary.

(6) Turn S300 to TEST OSC.
(7) Adjust C346 for a maximum reading on meter M501.
(8) Adjust C351 until the electronic counter indicates 100 mc ±250 cycles.
(9) Adjust C349 and C352 for a reading of 30 ua on meter M501.
(10) Readjust C351 as necessary to keep the frequency indication on the electronic counter within 250 cycles of 100 mc.
(11) Readjust C346 for a maximum reading on meter M501. Readjust C349, C352, and C351 as necessary.
(12) If it is impossible to obtain a reading of 30 ua on Meter M501, increase the capacitance of C340 slightly, and repeat the procedures in (6) through (11) above. Capacitor C340 must be kept as close to minimum capacitance as possible.

b. Adjustment of 100-Mc Lock Range.

(1) Turn S300 to USE.
(2) Adjust C351 for a 30-ua reading on meter M501.
(3) Turn S300 to TEST OSC, and check to see that the electronic counter is at 100 mc ±250 cycles (at a level of 30 ua on meter M501). If necessary, readjust C349 and C352.
(4) Turn S300 to USE.
(5) Adjust C351 slowly counterclockwise until meter M501 indicates a sharp jump and then tracks along with C351 as it is rotated. The electronic counter must indicate 100 mc ±1 cycle.
(6) Adjust C351 slowly counterclockwise until the bridge oscillator unlocks, the meter M501 reading changes sharply, and the electronic counter does not read within 1 cycle of 100 mc.
(7) Turn S300 to TEST OSC. The electronic counter must indicate at least 1,700 cycles less than 100 mc.
(8) Turn S300 to USE.
(9) Adjust C351 slowly clockwise until meter M501 reads 42 ua; the electronic counter must indicate 100 mc ±1 cycle.
(10) If the bridge oscillator frequency cannot be deviated at least 1,700 cycles in both directions, C341 is to be increased, the procedures given in *a*(4) through *a*(11) above and (1) through (9) above are to be repeated.
(11) Disconnect the electronic counter from 100MC OUTPUT connector J301.

c. Adjustment of 100-Mc Output.

(1) Turn S300 to USE.
(2) Connect a 50-ohm termination to 100MC OUTPUT connector J301 (fig. 2–13), and connect the AN/USM–98 across the 50-ohm termination. Adjust the AN/USM–98 for ac volts.
(3) Remove the shield to expose L363 (fig. 2–18).
(4) Adjust C369 and L363 for a maximum reading on the AN/USM–98.
(5) Replace the shield removed in (3) above.
(6) Readjust C369 for a maximum reading on the AN/USM–98. This voltage must be at least 1 volt.
(7) Remove the 50-ohm termination, leaving the AN/USM–98 connected across 100MC OUTPUT connector J301. The AN/USM–98 reading must increase by a factor of 1.5 to 2.5 without the 50-ohm termination.
(8) If it is impossible to obtain a 1-volt output as indicated in (6) above, proceed as follows:
(*a*) Turn S300 to USE.
(*b*) Connect the 50-ohm termination to J4 (fig. 2–14), and connect the AN/USM–98 across the 50-ohm termination. Remove the shield to expose L361 (fig. 2–18).
(*c*) Adjust C364 and L361 for a maximum reading on the AN/USM–98, and replace the shield removed in (*b*) above.
(*d*) Readjust C364 for a maximum indication on the AN/USM–98. The AN/USM–98 reading must be at least 1 volt.
(*e*) Repeat the procedures given in (1) through (7) above.

(9) If the output voltage is less than 1 volt for both 100-mc section outputs ((7) and (8) (*d*) above), adjust C349 to increase the two outputs, and then repeat the procedures given in *a*(6) through *a* (11) above, *b*(1) through *b* (9) above, and (1) through (7) above.

3–22. Test Equipment and Special Tools Required for Alignment of Generator, Signal SG–42/URM–18

The following test equipment is required for alignment of Generator, Signal SG–42/URM–18:

a. Frequency Meter AN/USM–26.
b. Voltmeter, Meter ME–30A/U.
c. Transformer, Variable Power CN–16/U.
d. Oscilloscope AN/USM–140A.

3–23. Signal Generator Preliminary Alignment

Perform preliminary alignment on the signal generator as follows:

a. Set capacitor C11 (fig. 2–50) to maximum capacitance.

b. Set capacitors C8 and C10 (fig. 2–50) to one-half capacitance.

c. Adjust resistors R3 and R15 (fig. 2–50) and R5 and R8 (fig. 2–48) to approximate midway settings.

d. Energize the signal generator.

e. Connect the ME–30A/U to the H-terminal of L2 (fig. 2–51).

f. Adjust R3 for a 2.5-volt dc indication on the ME–30A/U.

g. Remove the ME–30A/U from L2, and connect it to the H-terminal of L4 (fig. 2–51).

h. Adjust R15 for a 2.5-volt dc indication on the ME–30A/U.

i. Remove the ME–30A/U.

3–24. Signal Generator Rf Filter Adjustment

To perform the rf filter adjustment, proceed as follows:

a. Turn the REVERSE-DIRECT switch to DIRECT.

b. Adjust the direct frequency dial to a zero setting.

c. Turn OUTPUT control R22 (fig. 2–47) fully clockwise.

d. Turn INPUT control R34 (fig. 2–47) fully counterclockwise.

e. Connect an AN/USM–140A to OUTPUT jack J2 (fig. 2–47).

f. Adjust capacitors C21 and C22 (fig. 2–48) for a minimum deflection as indicated on the AN/USM–140A.

3–25. Signal Generator Dial Span Adjustment

Perform the dial span adjustment as follows:

a. Adjust C22 and C21 (fig. 2–48) so that each is one-half meshed.

b. Position the Δ f DIRECT dial to indicate an exact zero setting.

c. Position the direct frequency scale of the main FREQUENCY dials to 2, and set the lower dial of the main FREQUENCY dials to 0.

d. Position the REVERSE-DIRECT switch to DIRECT

e. Connect an electronic counter to OUTPUT jack J1.

f. Adjust C10 (fig. 2–47) to give a 200-cycle output indication on the electronic counter. Check to see that the indication of the electronic counter increases as the signal generator direct frequency scale reading is increased.

g. Adjust the FREQUENCY control until the electronic counter indicates 5,000 cycles. Apply the procedures in either (1) or (2) below.

(1) If the signal generator dial settings indicate a frequency greater than 5 kc, determine the frequency difference between the dial setting reading and 5 kc. Multiply this frequency by two to obtain a frequency product. Reset the signal generator dial settings to indicate a frequency which is equal to 5 kc minus the frequency product. Continue with *h* below.

(2) If the signal generator dial settings indicate a frequency less than 5 kc, determine the frequency difference between the dial setting reading and 5 kc. Multiply this frequency by two to obtain a frequency product. Reset

the signal generator dial settings to indicate a frequency which is equal to 5 kc plus the frequency product. For dial settings above 5 kc, keep a count of the lower dial revolutions. Each revolution equals 100 cycles. Continue with *h* below.

h. Readjust C21 and C22 to obtain a 5,000-cycle output as indicated on the electronic counter.

i. Readjust the signal generator direct frequency dial settings to indicate 200 cycles.

j. Adjust C10 and C11 for a 200-cycle output as indicated on the electronic counter.

k. Repeat the procedures given in *g* through *j* above until the correct frequency is obtained for 200 and 5,000 cycles.

3–26. Signal Generator Increment Capacitor Adjustment

a. Perform Δ f direct increment capacitor (C12) adjustment as follows:

(1) Connect the electronic counter to OUTPUT jack J2. Turn OUTPUT control R22 (fig. 2–47) fully clockwise, and turn INPUT control R34 fully counterclockwise.
(2) Position the REVERSE-DIRECT switch to DIRECT.
(3) Adjust the main FREQUENCY dials for a direct frequency setting of 2,500 cycles.
(4) Adjust the Δ f DIRECT dial to an exact zero setting.
(5) Adjust C10 (fig. 2–47) and C11 (fig. 2–51) until the electronic counter indicates exactly 2,500 cycles.
(6) Adjust the main FREQUENCY dials to indicate a direct frequency setting of 50 cycles.
(7) Adjust the Δ f DIRECT dial C12 to a +10-setting.
(8) Adjust the C12 left side (−10-side) stator plate, adjusting the nuts (fig. 2–48) to give a 60-cycle indication on the electronic counter. A span of 10 cycles will result between the 0- and +10-settings of the Δ f DIRECT dial.
(9) Readjust the Δ f DIRECT dial to zero.
(10) Adjust the main FREQUENCY dials to indicate a direct frequency setting of 60 cycles.
(11) Position the Δ f DIRECT dial C12 to a −10-setting.
(12) Adjust the C12 right side (+10-side) stator plate, adjusting the nuts (fig. 2–48) to give a 50-cycle indication on the electronic counter. A span of 10 cycles will result between the 0 and −10 settings of the Δ f DIRECT dial.
(13) Repeat the procedures given in (1) through (12) above, if necessary, until the adjustment of the Δ f DIRECT dial is within 0.2 cycle at the 0-, +10-, and −10-dial settings.
(14) Check the span adjustment of the main FREQUENCY dials, and readjust if necessary.

b. Perform Δ f REVERSE increment capacitor C9 adjustment as follows:

(1) Turn the REVERSE-DIRECT switch to REVERSE.
(2) Adjust the main FREQUENCY dials for a reverse frequency setting of 7,500 cycles.
(3) Adjust Δ f REVERSE dial to an exact zero setting.
(4) Adjust C8 to give a 2,500-cycle indication on the electronic counter.
(5) Readjust the main FREQUENCY dials to indicate a reverse frequency setting of 9,950 cycles. This will produce an output signal of 50 cycles, as indicated on the electronic counter.
(6) Adjust the Δ f REVERSE dial C9 to a +10-setting.
(7) Adjust the C9 left side (−10-side) stator plate, adjusting the nuts (fig. 2–48) to give a 60-cycle indication on the electronic counter. A span of 10 cycles will result between the 0- and +10-settings of the Δ f REVERSE dial.
(8) Set the Δ f REVERSE dial to zero.
(9) Adjust the main FREQUENCY dials to indicate a reverse frequency setting of 9,940 cycles. This will produce a 60-cycle indication on the electronic counter.

(10) Position Δ f REVERSE dial C9 to a −10-setting.

(11) Adjust the C9 right side (+10-side) stator plate, adjusting the nuts (fig. 2–48) for a 50-cycle indication on the electronic counter. A span of 10 cycles will result between the 0 and −10 settings of the Δ f REVERSE dial.

(12) Repeat the procedures given in (1) through (11) above, if necessary, until the adjustment of the Δ f REVERSE dial is within 0.2 cycle at the 0-, +10- and −10-dial settings. A check should be made to see that the output indication of 2,500 cycles does not change by turning the REVERSE-DIRECT switch from REVERSE to DIRECT with the main FREQUENCY dials indicating a direct frequency setting of 2,500 cycles. Check the electronic counter for results.

3–27. Signal Generator Reverse-Direct Voltage Equalization Adjustment

Perform the reverse-direct voltage equalization as follows:

a. Set the REVERSE-DIRECT switch to DIRECT.

b. Position the main FREQUENCY dials to indicate a direct frequency setting of 2,500 cycles.

c. Turn the OUTPUT control to a maximum clockwise position and the INPUT control to a maximum counterclockwise position.

d. Connect the ME–30A/U to OUTPUT jack J2 (fig. 2–47) to measure ac volts.

e. Adjust R5 (fig. 2–48) for a reading of 14 volts on the ME–30A/U. Panel meter M501 will read off-scale.

f. Set the REVERSE-DIRECT switch to REVERSE.

g. Adjust R8 (fig. 2–48) to give a 14-volt ac reading on the ME–30A/U.

h. Repeat the procedures in *e* through *g* above until the voltage does not change when the REVERSE-DIRECT switch is changed to either the REVERSE or DIRECT position.

3–28. Signal Generator Tuning Mechanism Backlash Adjustment

Perform the backlash adjustment as follows:

a. Connect the electronic counter to OUTPUT jack J2, turn OUTPUT control R22 (fig. 2–47) fully clockwise, and turn INPUT control R34 fully counterclockwise. Position the main FREQUENCY dials to indicate a direct frequency setting of zero.

b. Adjust C10 (fig. 2–47) so that the output frequency from the signal generator indicates exactly zero on the electronic counter.

c. Position the main FREQUENCY dials successively to indicate a direct frequency setting of 400, 425, 450, 475, 500, 1,000, 2,000, 3,000, 4,000, and 5,000 cycles. The indication of the electronic counter must not vary more than one-half of a division on the main FREQUENCY lower dial. If the indication is outside this limit, adjust the spring tension on the rear of the worm bearing to correct for excessive backlash.

3–29. Oscilloscope Adjustments

a. No special tools or test equipment are necessary for the adjustment of Oscilloscope OS–16A/URM–18. Perform adjustment procedures for R9 (fig. 2–53) as follows:

(1) Set the SELECTOR switch to X-STD. CIRC. SW.

(2) Set the CIRCULAR SWEEP FREQUENCY switch to LINE.

(3) Adjust the BRILLIANCE, FOCUS, VERT. CENTERING, HORIZ. CENTERING, and DIAMETER controls to obtain a circular pattern one-half the screen diameter.

(4) Adjust R9 and the SHAPING control to obtain best possible circular pattern.

b. To perform adjustment procedures for R10 (fig. 2–53), proceed as follows:

(1) Set the CIRCULAR SWEEP FREQUENCY switch to INTERP OSC, and set the SELECTOR switch to X-STD. CIRC. SW.

(2) Use the signal generator and the control panel to conduct a 2-volt, 3,500-cycle signal to the oscilloscope.

(3) Adjust the BRILLIANCE, FOCUS,

VERT. CENTERING, HORIZ. CENTERING, and DIAMETER controls to obtain a workable pattern.

(4) Adjust R10 and the SHAPING control to obtain the best possible circular pattern.

CHAPTER 4

DEPOT OVERHAUL STANDARDS

4–1. Applicability of Depot Overhaul Standards

The tests outlined in this chapter are designed to measure the performance capability of a repaired equipment. Equipment that is to be returned to stock should meet the standards given in these tests.

4–2. Applicable References

a. Repair Standards. Applicable procedures of the Electronics Command depots performing these tests and the general standards for repaired electronic equipment given in TB SIG 355–1, TB SIG 355–2, and TB SIG 355–3 form a part of the requirements for testing this equipment.

b. Modification Work Orders. Perform all applicable modification work orders pertaining to this equipment before making the tests specified. DA Pam 310–4 lists all available MWO's.

4–3. Test Facilities Required

The following equipments, or suitable equivalents, will be employed in determing compliance with the requirements of this Specific Standard.

a. Test Equipment.

Equipment	Federal stock No.	Quantity required	Applicable literature
Voltmeter, Meter ME–30A/U	6625–642–1670	1	TM 11–6625–320–12.
R. F. Signal Generator Set AN/URM–25D.	6625–309–5381	1	TM 11–5551–D.
Signal Generator SG–299/U	6625–624–3516	1	TM 11–5134–15.
Oscilloscope AN/USM–140A	6625–987–6603	1	TM 11–6625–535–15.
Digital Readout Electronic Counter AN/USM–207.	6625–911–6368	1	Data provided with equipment.
Multimeter TS–352/U	6625–242–5023	1	TM 11–5527.
Audio Oscillator TS–382F/U	6625–192–5094	2	TM 11–6625–261–12.

b. Additional Equipment.

Equipment	Federal stock No.	Quantity required
Cable Assembly, Radio Frequency.	5995–774–4241	3
General Radio Adaptor, Type 874-Q2.		2
General Radio Adaptor, Type 874-QBJL.		3
General Radio 50-ohm Termination, Type 874-W50B.		1
General Radio Tee, Type 874-T.		1
Headset, Electrical H–32/U.	5965–170–4814	1

4–4. Standard Frequency Oscillator O–1106/URM–18A Tests

a. With the frequency calibrator POWER switch in the STANDBY ONLY position, turn on the line power to the equipment. Allow 6 hours of warmup time for the frequency calibrator.

b. After the 6 hours of warmup, set the POWER switch to ON.

c. Check the meter current indications for each position of the METER SWITCH as follows.

(1) With the METER SWITCH in the AGC position, the meter should indicate between 10 and 25 microamperes.

(2) With the METER SWITCH in the OUTPUT position, the meter should indicate between 7 and 15 microamperes.

(3) With the METER SWITCH in the OSC PLATE position, the meter should indicate between 20 and 45 microamperes.

(4) With the METER SWITCH in the OVEN TEMPS-INNER position, the meter should indicate approximately 25 microamperes.

(5) With the METER SWITCH in the OVEN TEMPS-OUTER position, the meter should indicate between 27 and 30 microamperes.

Note. Make the required connections given in the procedures below using Cable Assembly, Radio Frequency (FSN 5595-774-4241); General Radio Adaptors, Type 874-Q2 and Type 874-QBJL; General Radio 50-ohm Termination, Type 874-W50B; and General Radio Tee, Type 874-T, as necessary.

d. With General Radio 50-ohm Termination, Type 874-W50B (50-ohm termination) connected to jack J201 on the frequency calibrator, measure the amplitude of the signal at J201 using Voltmeter, Meter ME–30A/U (vacuum tube voltmeter). The vacuum tube voltmeter should indicate an amplitude of 0.5 volt to 1.0 volt. Remove the 50-ohm termination and the vacuum tube voltmeter from the frequency calibrator.

e. Connect jack J201 to the FREQ. An input connector on Digital Readout Electronic Counter AN/USM–207, and measure the frequency of the output signal of the frequency calibrator. The AN/USM–207 should indicate 5,000,000 cps.

f. Connect jack J202 to the FREQ. A input connector on the AN/USM–207 and measure the frequency of the output signal of the frequency calibrator. The AN/USM–207 should indicate 5,000,000 cps.

g. After 1 hour, repeat the procedure given in *f* above. Turn the power off, and disconnect the equipment.

4–5. Frequency Multiplier CV–1518/URM–18A Tests

a. Connect the frequency multiplier for a 100-kc input as follows:

(1) Connect P100 to J100.

(2) Connect P2 to J2.

(3) Connect P3 to J3.

b. Set the POWER-OFF switch to POWER, and allow 3 hours of warmup time for the frequency multiplier.

Note. Make the required connections given in the procedures below using Cable Assembly, Radio Frequency (FSN 5995-774-4241) and General Radio Adaptor, Type 874-QBJL (2 each), as necessary.

c. After the 3 hours of warmup, apply an input signal of 100kc at 1-volt amplitude to STD INPUT jack J1 using R. F. Signal Generator Set AN/URM–25D.

d. Connect 1MC OUTPUT jack J101 on the frequency multiplier to the FREQ. A input connector on Digital Readout Electronic Counter AN/USM–207, and measure the frequency of the output signal at J101. The AN/USM–207 should indicate 1,000,000 cps.

e. Connect the frequency multiplier for a 5-mc input as follows:

(1) Disconnect P100 from J100.

(2) Disconnect P2 from J2.

(3) Disconnect P3 from J3.

(4) Connect P2 to J3.

(5) Connect P100 to J200.

f. Apply an input signal of 5 mc at 1-volt amplitude to STD INPUT jack J1, using the AN/URM–25D.

g. Connect 10 MC OUTPUT jack J201 on the frequency multiplier to the FREQ. A connector on the AN/USM–207, and measure the frequency of the output signal at J201. The AN/USM–207 should indicate 10,000,000 cps.

h. Connect 100 MC OUTPUT jack J301 on the frequency multiplier to the FREQ. A connector on the AN/USM–207, and measure the frequency of the output signal at J301. The AN/USM–207 should indicate 100,000,000 cps.

i. Turn off the power, and disconnect the equipment.

4–6. Frequency Divider CV–1517/URM–18A Tests

a. Apply power to the frequency divider.

Note. Make the required connections given in the procedures below using Cable Assembly, Radio Frequency (FSN 5995-774-4241) and General Radio Adaptor, Type 874-QBJL (3 each), as necessary.

b. With DRIVING FREQ switch S801 (located behind front panel) set to 5 MC, connect INPUT 5 MC jack J102 on the frequency divider to R. F. Signal Generator Set AN/URM–25D, and apply an input signal of 5 mc at 1-volt amplitude to J102.

c. Using Digital Readout Electronic Counter AN/USM–207, measure the frequency of the signal at OUTPUT 1 MC jack J101. The AN/USM–207 should indicate a 1-mc signal.

d. Using Oscilloscope AN/USM–140A, measure the frequency of the signal at OUTPUT 100 KC ∿ jack J202. The AN/USM–140A should indicate a 100-kc, square-wave signal.

e. Using the AN/USM–140A, measure the frequency of the signal at OUTPUT 100 KC jack J201. The AN/USM–140A should indicate a 100-kc, sine-wave signal.

f. Using the AN/USM–140A, measure the frequency of the signal at OUTPUT 10 KC jack J302. The AN/USM–140A should indicate a 10-kc, square-wave signal.

g. Using the AN/USM–140A, measure the frequency of the signal at OUTPUT 10 KC jack J301. The AN/USM–140A should indicate a 10-kc, sine-wave signal.

h. Using the AN/USM–140A, measure the frequency of the signal at OUTPUT 1 KC jack J402. The AN/USM–140A should indicate a 1-kc signal.

i. Using the AN/USM–140A, measure the frequency of the signal at OUTPUT 1 KC jack J401. The AN/USM–140A should indicate a 1-kc signal.

j. Using the AN/USM–140A, measure the frequency of the signal at OUTPUT 100 C jack J501. The AN/USM–140A should indicate a 100-cps signal.

k. Disconnect the AN/URM–25D from INPUT 5 MC jack J102, and connect it to INPUT 1 MC ∿ jack J203. Set the DRIVING FREQ switch S801 to 1MC. Apply an input signal of 1 mc at 1 volt to J203.

l. Using the AN/USM–140A, measure the frequency of the signal at OUTPUT 100 KC jack J202. The AN/USM–140A should indicate a 100-kc, square-wave signal.

m. Using the AN/USM–140A, measure the frequency of the signal at OUTPUT 100 KC jack J201. The AN/USM–140A should indicate a 100-kc, sine-wave signal.

n. Using the AN/USM–140A, measure the frequency of the signal at OUTPUT 10 KC jack J302. The AN/USM–140A should indicate a 10-kc, square-wave signal.

o. Using the AN/USM–140A, measure the frequency of the signal at OUTPUT 10 KC jack J301. The AN/USM–140A should indicate a 10-kc, sine-wave signal.

p. Using the AN/USM–140A, measure the frequency of the signal at OUTPUT 1 KC jack J402. The AN/USM–140A should indicate a 1-kc signal.

q. Using the AN/USM–140A, measure the frequency of the signal at OUTPUT 1 KC jack J401. The AN/USM–140A should indicate a 1-kc signal.

r. Using the AN/USM–140A, measure the frequency of the signal at OUTPUT 100 C jack J501. The AN/USM–140A should indicate a 100-cps signal.

s. Disconnect the AN/URM–25D from INPUT 1 MC ∿ jack J203, and connect it to INPUT 100 KC jack J303. Set the DRIVING FREQ switch S801 to 100 KC. Apply an input signal of 100 kc at 1 volt to J303.

t. Using the AN/USM–140A, measure the frequency of the signal at OUTPUT 10 KC jack J302. The AN/USM–140A should indicate a 10-kc, square-wave signal.

u. Using the AN/USM–140A, measure the frequency of the signal at OUTPUT 10 KC jack J301. The AN/USM–140A should indicate a 10-kc, sine-wave signal.

v. Using the AN/USM–207, measure the frequency of the signal at OUTPUT 1 KC jack J402. The AN/USM–207 should indicate a 1-kc signal.

w. Using the AN/USM–207, measure the

frequency of the signal at OUTPUT 1 KC jack J401. The AN/USM–207 should indicate a 1-kc signal.

x. Using the AN/USM–207, measure the frequency of the signal at OUTPUT 100 C jack J501. The AN/USM–207 should indicate a 100-cps signal.

y. Turn off power, and disconnect the equipment.

4–7. Frequency Meter FR–43A/URM–18 Tests

a. Set the PLATE-OFF switch to OFF and the POWER-OFF switch to POWER. After 15 minutes warmup, set the PLATE-OFF switch to PLATE.

b. Set the low-frequency meter fine control to midrange.

Note. Make the required connections given in the procedures below using Cable Assembly, Radio Frequency (FSN 5994-774-4241), and General Radio Adaptor, Type 874-QBJL, as necessary.

c. Connect FREQ. METER OUTPUT jack J1 to the FREQ. A connector on Digital Readout Electronic Counter AN/USM–207, and measure the frequency of the output signal at each frequency numbered point of the FREQUENCY METER dial for the 100-kc through 141-kc range and for the 141-kc through 200-kc range. The accuracy should be ±0.1 percent of the frequency at each of the test points.

d. Disconnect the AN/USM–207 from the low-frequency meter.

e. Connect FREQ. METER OUTPUT jack J1 to DETECTOR INPUT jack J2 and connect Headset, Electrical H–32/U to DETECTOR OUTPUT jack J3.

f. Perform a zero-beat frequency check at each frequency numbered point of the FREQUENCY METER dial for each of the nine ranges (100-kc through 2,000-kc). Beat tones should be heard at the same dial settings of the FREQUENCY METER dial and the DETECTOR dial.

g. Set the PLATE-OFF switch to OFF and the POWER-OFF switch to OFF.

4–8. Frequency Meter FR–44/URM–18 Tests

a. Set the PLATE-OFF switch to OFF and the POWER-OFF switch to POWER. After 15 minutes warmup, set the PLATE-OFF switch to PLATE.

b. Set the medium-frequency meter fine control to midrange.

Note. Make the required connections given in the procedures below using Cable Assembly, Radio Frequency (FSN 5995-774-4241), and General Radio Adaptor, Type 874-QBJL, as necessary.

c. Connect FREQ. METER OUTPUT jack J1 to the FREQ. A connector on Digital Readout Electronic Counter AN/USM–207, and measure the frequency of the output signal at each frequency numbered point of the FREQUENCY METER dial for the 1-mc through 1.26-mc range, for the 1.26-mc through 1.59-mc range, and for the 1.59-mc through 2-mc range. The accuracy should be ±0.1 percent of the frequency at each of the test points.

d. Disconnect the AN/USM–207 from the medium-frequency meter.

e. Connect FREQ. METER OUTPUT jack J1 to DETECTOR INPUT jack J2, and connect Headset, Electrical H–32/U to DETECTOR OUTPUT jack J3.

f. Perform a zero-beat frequency check at each frequency numbered point of the FREQUENCY METER dial for each of the 10 ranges (1-mc through 10-mc). Beat tones should be heard at the same dial settings of the FREQUENCY METER dial and the DETECTOR dial.

g. Set the PLATE-OFF switch to OFF and the POWER-OFF switch to OFF.

4–9. Frequency Meter FR–45A/URM–18 Tests

a. Set the PLATE-OFF switch to OFF and the POWER-OFF switch to POWER. After 15 minutes warmup, set the PLATE-OFF switch to PLATE.

b. Set the high-frequency meter fine control to midrange.

Note. Make the required connections given in the procedures below using Cable Assembly, Radio Frequency (FSN 5995-774-4241), and General Radio Adaptor, Type 874-QBJL, as necessary.

c. Connect FREQ. METER OUTPUT jack J1 to the FREQ. A connector on Digital Readout Electronic Counter AN/USM–207, and meas-

ure the frequency of the output signal at each frequency numbered point of the FREQUENCY METER dial for the 10-mc through 12.6-mc range, for the 12.6-mc through 15.9-mc range, and for the 15.9-mc through 20-mc range. The accuracy should be ±0.1 percent of the frequency at each of the test points.

d. Disconnect the AN/USM–207 from the high-frequency meter.

e. Connect FREQ. METER OUTPUT jack J1 to DETECTOR INPUT jack J2, and connect Headset, Electrical H–32/U to DETECTOR OUTPUT jack J3.

f. Perform a zero-beat frequency check at each frequency numbered point of the FREQUENCY METER dial for each of the 10 ranges (10-mc through 100-mc). Beat tones should be heard at the same dial settings of the FREQUENCY METER dial and the DETECTOR dial.

g. Set the PLATE-OFF switch to OFF and the POWER-OFF switch to OFF.

4–10. Generator, Signal SG–42/URM–18 Tests

a. Set the ON-OFF power switch on the signal generator to ON.

Note. Make the required connections given in the procedures below using Cable Assembly, Radio Frequency (FSN 5995-774-4241), and General Radio Adaptors, Type 874-QBJL and Type 874-Q2, General Radio 600-ohm Termination, and General Radio Tee, Type 874-T, as necessary.

b. Connect signal generator OUTPUT jack J2 to the FREQ. A connector of the Digital Readout Electronic Counter AN/USM–207.

c. Set the REVERSE-DIRECT switch to DIRECT and the Δ f DIRECT control to zero on the Δ f DIRECT dial.

d. Adjust the frequency control for a reading of 30 cps on the FREQUENCY dial. Using the AN/USM–207, measure the output signal. The AN/USM–207 should indicate 30 ±2 cps.

e. Adjust the frequency control for a reading of 1,000 cps on the FREQUENCY dial, and measure the output signal. The AN/USM–207 should indicate 1,000 ±2 cps. Connect signal generator OUTPUT jack J4 to the input of Oscilloscope AN/USM–140A. Observe the output signal of the signal generator (1,000 cps) on the AN/USM–140A. The AN/USM–140A should display a 1,000-cps, undistorted sine-wave signal. Disconnect the AN/USM–140A from the signal generator.

f. Adjust the Δ f DIRECT control (do not adjust the frequency control) for a reading of 1,010 cps on the FREQUENCY dial, and measure the output signal. The AN/USM–207 should indicate 1,010 ±2 cps.

g. Adjust the Δ f DIRECT control (do not adjust the frequency control) for a reading of 990 cps on the FREQUENCY dial, and measure the output signal. The AN/USM–207 should indicate 990 ±2 cps.

h. Set the Δ f DIRECT control to indicate zero on the Δ f DIRECT dial.

i. Adjust the frequency control for a reading of 5,000 cps on the FREQUENCY dial, and measure the output signal. The AN/USM–207 should indicate 5,000 ±2 cps.

j. Repeat the procedures given in *c* through *i* above with the REVERSE-DIRECT switch set to REVERSE and the Δ f REVERSE control used instead of the Δ f DIRECT control.

k. Disconnect the AN/USM–207 from the signal generator.

l. With General Radio Tee, Type 874-T, and General Radio 600-ohm Termination (600-ohm termination), connected to signal generator OUTPUT jack J2, connect Voltmeter, Meter ME–30A/U to J2, and connect Audio Oscillator TS–382F/U to the INPUT binding post of the signal generator.

m. Adjust the TS–382/U to produce signals of 30 cps at 0.15 volt, 1,000 cps at 0.15 volt, and 5,000 cps at 0.15 volt. Using the OUTPUT meter on the signal generator and the ME–30A/U, measure the amplitude of the 30-cps, 1,000-cps, and 5,000-cps signals. The OUTPUT meter and the ME–30A/U should agree within 5 percent and indicate a minimum amplitude of 3 volts for 30 cps, 1,000 cps, and 5,000 cps.

n. Disconnect the ME–30A/U from the signal generator.

o. Adjust the signal generator for a 1,000-cps output signal with INPUT and OUTPUT controls set to midposition.

p. Using the TS–382F/U, apply a 1,000-cps signal at 1-volt amplitude to INPUT jack J1 on the signal generator.

q. Adjust the output frequency of the signal generator for a zero beat, while observing the indication on the OUTPUT meter. The OUTPUT meter should indicate a zero beat when both signals (output of the signal generator and the TS–382F/U) are at the same frequency.

4–11. Oscilloscope OS–16A/URM–18 Tests

a. Set the POWER-OFF switch on the oscilloscope to POWER.

b. Set the SELECTOR switch to X-INTERP. CIRC. SW and the CIRCULAR SWEEP FREQUENCY switch to LINE. Adjust the DIAMETER, SHAPING, HORIZ. CENTERING, VERT, CENTERING, FOCUS, and BRILLIANCE controls for a good, centered, one-half screen diameter. For the tests given below, adjust the DIAMETER control necesary for a one-half screen diameter.

Note. Make the required connections given in the procedures below using Cable Assembly, Radio Frequency (FSN 5995-774-4241) and General Radio Adaptors, Type 874-Q2, as necessary.

c. Connect Audio Oscillator TS–382F/U to the connector on 100 ∿ jack J4. Set the CIRCULAR SWEEP FREQUENCY switch to 100 Δ. Adjust for a 100-cps output signal at 3 volts amplitude. The oscilloscope should display a circular sweep pattern.

d. Remove the TS–382F/U from J4, and mount it on 1-kc jack J3. Set the CIRCULAR SWEEP FREQUENCY switch to 1 kc. Adjust the TS–382F/U for a 1,000-cps output signal at 3 volts amplitude. The oscilloscope should display a circular sweep pattern.

e. Remove the TS–382F/U from J3, and mount it on 10-kc jack J2. Set the CIRCULAR SWEEP FREQUENCY switch to 10 kc. Adjust the TS–382F/U for a 10,000-cps output signal at 3 volts amplitude. The oscilloscope should display a circular sweep pattern.

f. Remove the TS–382F/U from J2, and mount it on INTERP OUT jack J5. Set the CIRCULAR SWEEP FREQUENCY switch to INTERP. OSC. Adjust the TS–382F/U for a 3,500-cps output signal at 2.5 volts amplitude. Vary the amplitude of the output signal of the TS–382F/U. The oscilloscope should display a circular sweep pattern with the diameter varying as the amplitude of the output signal of the TS–382F/U is varied.

g. Connect a second TS–382F/U to X-jack J1. Set the SELECTOR switch to X-INTERP. CIRC. SW. The CIRCULAR SWEEP FREQUENCY switch may be in any position for this test. Adjust both TS–382F/U's for a 3,500-cps output signal at 2.5 volts amplitude. The oscilloscope should display a one-tooth gearwheel pattern.

h. Remove the TS–382F/U from J5, and mount it on 100 ∿ jack J4. Set the SELECTOR switch to X-STD. CIRC. SW, and set the CIRCULAR SWEEP FREQUENCY switch to 100 ∿ . Adjust the TS–382F/U connected to J4 for a 100-cps output signal at 3 volts amplitude. Adjust the TS–382F/U connected to J1 for a 500-cps output signal at 0.5-volt amplitude. The oscilloscope should display a five-tooth gearwheel pattern. (This pattern will not be stationary because the TS–382F/U's are not synchronized.)

i. Remove the TS–382F/U from J1, and mount it on DET. OUT. jack J6. Set the SELECTOR switch to DET.-STD. CIRC. SW, and set the CIRCULAR SWEEP FREQUENCY switch to 100 ∿ . Adjust the TS–382F/U connected to J4 for a 100-cps output signal at 3 volts amplitude. Adjust the TS–382F/U connected to J6 for a 500-cps output signal at 0.5-volt amplitude. The oscilloscope should display a five-tooth gearwheel pattern. (This pattern will not be stationary because the TS-382F/U's are not synchronized.)

j. Remove the TS–382F/U from J4, and mount it on INTERP. OUT. jack J5. Set the SELECTOR switch to INTERP.-STD. CIRC. SW and the CIRCULAR SWEEP FREQUENCY switch to 100 ∿ . Adjust the TS–382F/U connected to J5 for a 100-cps output signal at 3 volts amplitude. Adjust the TS–382F/U connected to J6 for a 500-cps output signal at 0.5-volt amplitude. The oscilloscope should display a five-tooth gearwheel pattern. (This pattern will not be stationary because the TS–382F/U's are not synchronized.)

k. Set the SELECTOR switch to DET.-INTERP. and the CIRCULAR SWEEP FREQUENCY switch to 100 ∿ . Adjust the

TS–382F/U connected to J5 for a 100-cps output signal at 2 volts amplitude. Adjust the TS–382F/U connected to J6 for a 100-cps output signal at 1-volt amplitude. The oscilloscope should display a 1 to 1 frequency Lissajous pattern.

l. Turn the equipment to OFF.

m. Disconnect the equipment.

4–12. Panel, Control SB–105A/URM–18 Tests

a. Resistance Test. Using Multimeter TS–352/U as an ohmmeter, perform the resistance tests given in the chart below:

Note: Make the required connections given in the procedures below using Cable Assembly, Radio Frequency (FSN 5995-774-4241), General Radio Adaptor, Type 874-Q2, and General Radio Adaptor, Type 874-QBJL, as necessary.

b. Harmonic Generator Test. Using R. F. Signal Generator Set AN/URM–25D and Signal Generator SG–299/U as necessary, perform the harmonic generator tests given in the chart below;

Signal generator output signal	Signal generator connection	Switch positions for test							Control setting for test			Oscilloscope connection	Oscilloscope indication
		Power-OFF	Stand. freq harmonics selector	Stand. freq harmonics fx-select	Frequency meter	Detector	Detector interpolator	Microdial	fx	Stand. freq harmonics 100 kc	Stand. freq harmonics 10 kc		
100 kc Square-wave at 2 volts amplitude.	J11	ON	100 kc or 100/10 kc	fx-1 or fx-1 & 2					Vary thru-out range.	Vary thru-out range.		J6	Complex signal that varies in amplitude as controls are varied.
100 kc Square-wave at 2 volts amplitude.	J11	ON	100 kc or 100/10 kc	fx-2 or fx-1 & 2					Vary thru-out range.	Vary thru-out range.		J13	Complex signal that varies in amplitude as controls are varied.
100 kc Square-wave at 2 volts amplitude.	J11	ON	100 kc or 100/10 kc		L							J5	Complex signal.
100 kc Square-wave at 2 volts amplitude.	J11	ON	100 kc or 100/10 kc		M							J7	Complex signal.
100 kc Square-wave at 2 volts amplitude.	J11	ON	100 kc or 100/10 kc		H							J10	Complex signal.
100 kc Square-wave at 2 volts amplitude.	J11	ON	100 kc or 100/10 kc			L						J26	Complex signal.
100 kc Square-wave at 2 volts amplitude.	J11	ON	100 kc or 100/10 kc			M						J24	Complex signal.
100 kc Square-wave at 2 volts amplitude.	J11	ON	100 kc or 100/10 kc			H						J22	Complex signal.
100 kc Square-wave at 2 volts amplitude.	J11	ON	100 kc or 100/10 kc			EXT.						J20	Complex signal.
100 kc Square-wave at 2 volts amplitude.	J12	ON	10 kc or 100/10 kc	fx-1 or fx-1 & 2					Vary thru-out range.		Vary thru-out range.	J6	Complex signal that varies in amplitude as controls are varied.
100 kc Square-wave at 2 volts amplitude.	J12	ON	10 kc or 100/10 kc	fx-2 or fx-1 & 2					Vary thru-out range.		Vary thru-out range.	J13	Complex signal that varies in amplitude as controls are varied.

Connect ohmmeter leads		Switch positions for test							Control setting for test			Ohmmeter indication (ohms ±20 percent)
From	To	Power-OFF	Stand. freq harmonics selector	Stand. freq harmonics fx select	Frequency meter	Detector	Detector interpolator	Microdial	fx	Stand. freq harmonics 100 kc	Stand. freq harmonics 10 kc	
J18	J27	OFF				L	Detector SPKR					145
J18	J27	OFF				L	Detector TEL, OFF, interpolator TEL, or interpolator SPKR.					Infinity
J1	J2	OFF										Less than 1
J2	J27	OFF				L	Detector TEL.					145
J2	J27	OFF				L	Detector SPKR, OFF, interpolator TEL, or interpolator SPKR.					Infinity
J2	J28	OFF										Less than 1
J14	J25	OFF				M						145
J14	J23	OFF				H						145
J14	J21	OFF				EXT.						145
J20	GND	OFF										Infinity
J22	GND	OFF										Infinity
J24	GND	OFF										Infinity
J26	GND	OFF										Infinity
J6	GND	OFF	OFF	GND or fx-2								Infinity
J6	GND	OFF	OFF	fx-1 or fx-1 & 2					Fully counter-clockwise.			500
J6	GND	OFF	OFF	fx-1 or fx-1 & 2					Fully clockwise			188
J13	GND	OFF	OFF	GND or fx-1								Infinity
J13	GND	OFF	OFF	fx-2 or fx-1 & 2					Fully counter-clockwise			500
J13	GND	OFF	OFF	fx-2 or fx-1 & 2					Fully clockwise			188
J5	J9	OFF										Less than 1
J4	J7	OFF										Less than 1
J5	GND	OFF	OFF		L or L-M				Fully counter-clockwise			67
J5	GND	OFF	OFF		L or L-M				Fully clockwise			150
J4	GND	OFF	OFF		M or L-M				Fully counter-clockwise			67
J4	GND	OFF	OFF		M or L-M				Fully clockwise			150
J3	J8	OFF										Less than 1
J3	GND	OFF										Infinity
J14	J16	OFF										Less than 1
J14	J27	OFF				L						145
J19	J27	OFF				L		OFF or S.C.				Infinity
J19	J27	OFF				L		ON				145

APPENDIX

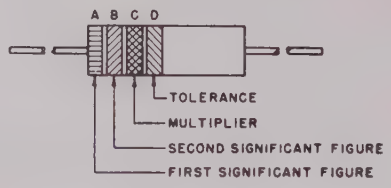
REFERENCES

Following is a list of references available to the general support and depot maintenance personnel of Calibrator Set, Frequency AN/URM–18A.

DA Pam 310–4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins, Lubrication Orders, and Modification Work Orders.
TB SIG 355–1	Depot Inspection Standard for Repaired Signal Equipment.
TB SIG 355–2	Depot Inspection Standard for Refinishing Repaired Signal Equipment.
TB SIG 355–3	Depot Inspection Standard for Moisture and Fungus Resistant Treatment.
TM 11–5057	Frequency Meter AN/USM–26.
TM 11–5094	Frequency Meters AN/URM–79 and AN/URM–82.
TM 11–5134–15	Organizational, DS, GS, and Depot Maintenance Manual: Signal Generator SG–299/U, SG–299A/U, SG–299B/U, and SG–299C/U.
TM 11–5527	Multimeters TS–352/U, TS–352A/U, and TS–352B/U.
TM 11–5551	Instruction Book for R-F Signal Generator Set AN/URM–25.
TM 11–5551D	R. F. Signal Generator Set AN/URM–25D.
TM 11–6625–203–12	Operator and Organizational Maintenance: Multimeter AN/URM–105, including Multimeter ME–77/U.
TM 11–6625–239–12	Operator's and Organizational Maintenance Manual; Electronic Multimeters TS–505/U, TS–505A/U, and TS–505B/U and Multimeters TS–505C/U, and TS–505D/U.
TM 11–6625–261–12	Operator's and Organizational Maintenance Manual; Audio Oscillators TS–382A/U, TS–382B/U, TS–382D/U, TS–382E/U, and TS–382F/U.
TM 11–6625–274–12	Operator's and Organizational Maintenance Manual; Test Sets Electron Tube TV–7/U, TV–7A/U, TV–7B/U, and TV–7D/U.
TM 11–6625–320–12	Organizational Maintenance Manual; Voltmeter, Meter ME–30A/U and Voltmeters, Electronic ME–30B/U, ME–30C/U, and ME–30E/U.
TM 11–6625–438–10	Operator's Manual; Voltmeter, Electronic AN/USM–98.
TM 11–6625–535–15	Organizational, DS, GS, and Depot Maintenance Manual: Oscilloscope AN/USM–140A.
TM 11–6625–539–15	Operator, Organizational, Field and Depot Maintenance Manual: Test Sets, Transistor TS–1836/U.
TM 38–750	Army Equipment Record Procedures.

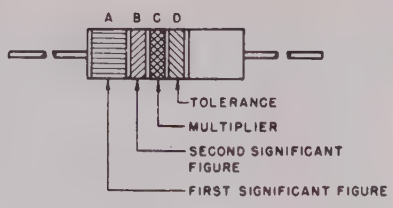
COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS

COMPOSITION-TYPE RESISTORS



BAND A— Equal Width Band Signifies Composition-Type

WIREWOUND-TYPE RESISTORS

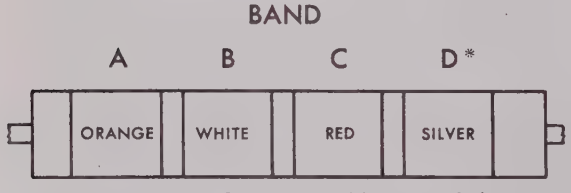


BAND A— Double Width Signifies Wire-wound Resistor

COLOR CODE TABLE

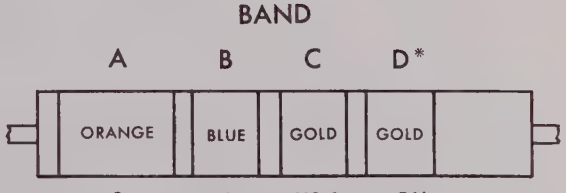
BAND A		BAND B		BAND C		BAND D*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1		
BROWN	1	BROWN	1	BROWN	10		
RED	2	RED	2	RED	100		
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000	SILVER	± 10
GREEN	5	GREEN	5	GREEN	100,000	GOLD	± 5
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	SILVER	0.01		
WHITE	9	WHITE	9	GOLD	0.1		

EXAMPLES OF COLOR CODING



NOMINAL RESISTANCE 3,900 Ohms

RESISTANCE TOLERANCE ± 10 percent



3.6 Ohms

± 5 percent

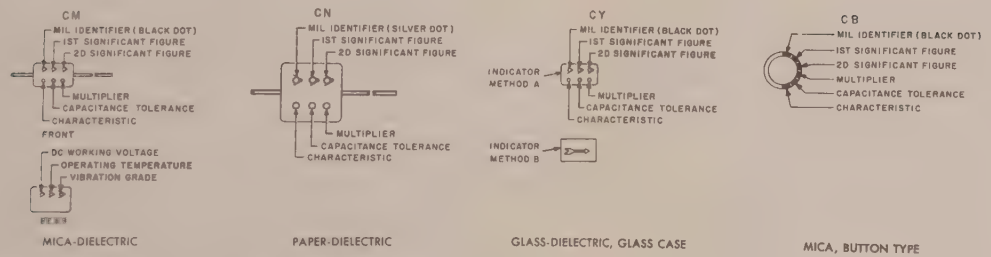
STD-R2

*If Band D is omitted, the resistor tolerance is ±20%, and the resistor is not Mil-Std.

Figure 4–1. Color code marking for MIL STD resistors.

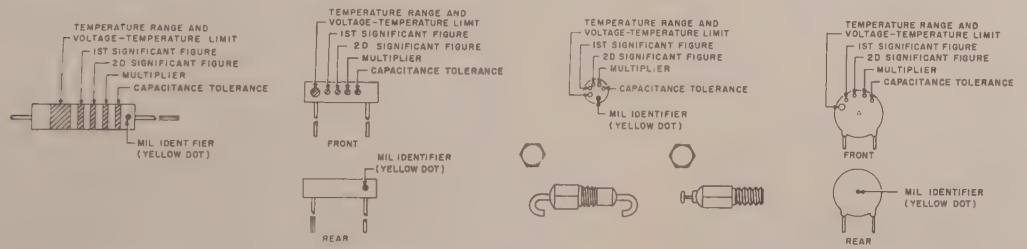
COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS

GROUP I Capacitors, Fixed, Various-Dielectrics, Styles CM, CN, CY, and CB



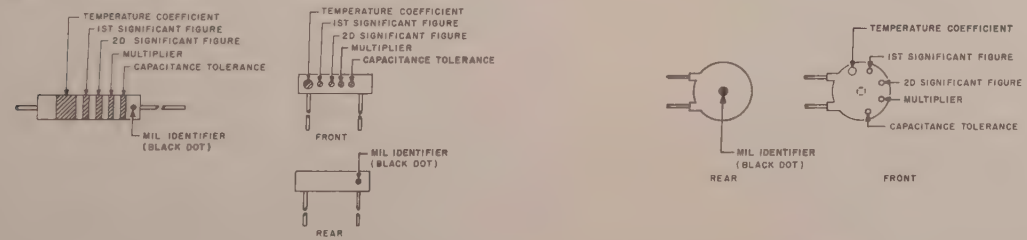
MICA-DIELECTRIC PAPER-DIELECTRIC GLASS-DIELECTRIC, GLASS CASE MICA, BUTTON TYPE

GROUP II Capacitors, Fixed Ceramic-Dielectric (General Purpose) Style CK



AXIAL LEAD RADIAL LEAD FEED-THROUGH STAND-OFF DISK-TYPE

GROUP III Capacitors, Fixed, Ceramic-Dieletric (Temperature Compensating) Style CC



AXIAL LEAD RADIAL LEAD DISK-TYPE

COLOR CODE TABLES

TABLE I – For use with Group I, Styles CM, CN, CY and CB

COLOR	MIL ID	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE				CHARACTERISTIC[2]				DC WORKING VOLTAGE	OPERATING TEMP. RANGE	VIBRATION GRADE
					CM	CN	CY	CB	CM	CN	CY	CB	CM	CM	CM
BLACK	CM, CY CB	0	0	1			± 20%	± 20%		A				−55° to +70°C	10–55 cps
BROWN		1	1	10					B	E		B			
RED		2	2	100	± 2%		± 2%	± 2%	C		C			−55° to +85°C	
ORANGE		3	3	1,000		± 30%			D			D	300		
YELLOW		4	4	10,000					E					−55° to +125°C	10–2,000 cps
GREEN		5	5		± 5%				F				500		
BLUE		6	6											−55° to +150°C	
PURPLE (VIOLET)		7	7												
GREY		8	8												
WHITE		9	9												
GOLD				0.1			± 5%	± 5%							
SILVER	CN				± 10%	± 10%	± 10%	± 10%							

TABLE II – For use with Group II, General Purpose, Style CK

COLOR	TEMP. RANGE AND VOLTAGE – TEMP. LIMITS[3]	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE	MIL ID
BLACK		0	0	1	± 20%	
BROWN	AW	1	1	10	± 10%	
RED	AX	2	2	100		
ORANGE	BX	3	3	1,000		
YELLOW	AV	4	4	10,000		CK
GREEN	CZ	5	5			
BLUE	BV	6	6			
PURPLE (VIOLET)		7	7			
GREY		8	8			
WHITE		9	9			
GOLD						
SILVER						

TABLE III – For use with Group III, Temperature Compensating, Style CC

COLOR	TEMPERATURE COEFFICIENT[4]	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE		MIL ID
					Capacitances over 10uuf	Capacitances 10uuf or less	
BLACK	0	0	0	1		± 2.0uuf	CC
BROWN	−30	1	1	10	± 1%		
RED	−80	2	2	100	± 2%	± 0.25uuf	
ORANGE	150	3	3	1,000			
YELLOW	220	4	4				
GREEN	330	5	5		± 5%	± 0.5uuf	
BLUE	470	6	6				
PURPLE (VIOLET)	750	7	7				
GREY		8	8	0.01			
WHITE		9	9	0.1	± 10%		
GOLD	± 100					± 1.0uuf	
SILVER							

1. The multiplier is the number by which the two significant (SIG) figures are multiplied to obtain the capacitance in uuf.
2. Letters indicate the Characteristics designated in applicable specifications: MIL–C–5, MIL–C–91, MIL–C–11272, and MIL–C–10950 respectively.
3. Letters indicate the temperature range and voltage-temperature limits designated in MIL–C–11015.
4. Temperature coefficient in parts per million per degree centigrade.

STD–C2

Figure 4–2. Color code marking for MIL STD capacitors.

1 Clamp, light pipe
2 Screw
3 Washer
4 Light pipe
5 Capacitor (C21)
6 Screw
7 Washer
8 Bracket
9 Screw
10 Washer
11 Bracket
12 Screw
13 Washer
14 Terminal
15 Capacitor (C22)
16 Screw
17 Washer
18 Plate
19 Screw
20 Washer
21 Mask
22 Screw
23 Nut
24 Washer
25 Bracket
26 Screw
27 Washer
28 Ring, retaining
29 Washer
30 Dial
31 Setscrew
32 Bushing
33 Screw
34 Nut
35 Washer
36 Gear
37 Washer
38 Washer
39 Guide
40 Screw
41 Washer
42 Plunger
43 Spring
44 Screw
45 Washer
46 Plate
47 Screw
48 Washer
49 Washer
50 Shaft
51 Nut
52 Washer
53 Washer
54 Collar
55 Setscrew
56 Nut
57 Washer
58 Washer
59 Bushing
60 Gear
61 Shaft
62 Spur and worn gear
63 Setscrew
64 Arm, tension spring
65 Screw
66 Washer
67 Screw, adjusting
68 Locknut
69 Spacer
70 Spring, tension
71 Nut
72 Spacer
73 Spring, bearing
74 Holder, bearing
75 Screw
76 Washer
77 Shims
78 Bearing, ball
79 Plate
80 Screw
81 Dial
82 Gear
83 Setscrew
84 Screw
85 Nut
86 Clamp
87 Screw
88 Washer
89 Bearing, ball
90 Bearing block
90A Washer
90B Screw
91 Worm shaft
92 Plate, cover
93 Screw
94 Washer
95 Gear assembly
96 Setscrew
97 Washer
98 Collar
99 Setscrew
100 Washer
101 Nut
102 Washer
103 Washer
104 Bushing
105 Shaft
106 Shield
107 Screw
108 Washer
109 Stud
110 Washer
111 Support
112 Screw
113 Washer
114 Nut
115 Washer
116 Terminal
117 Nut
118 Washer
119 Washer
120 Insulator
121 Washer
122 Nut
123 Washer
124 Washer
125 Insulator
126 Washer
127 Nut
128 Bushing
129 Bearing, ball
130 Nut
131 Washer
132 Spacer
133 Spring, contact
134 Spacer
135 Screw
136 Nut
137 Washer
138 Frame

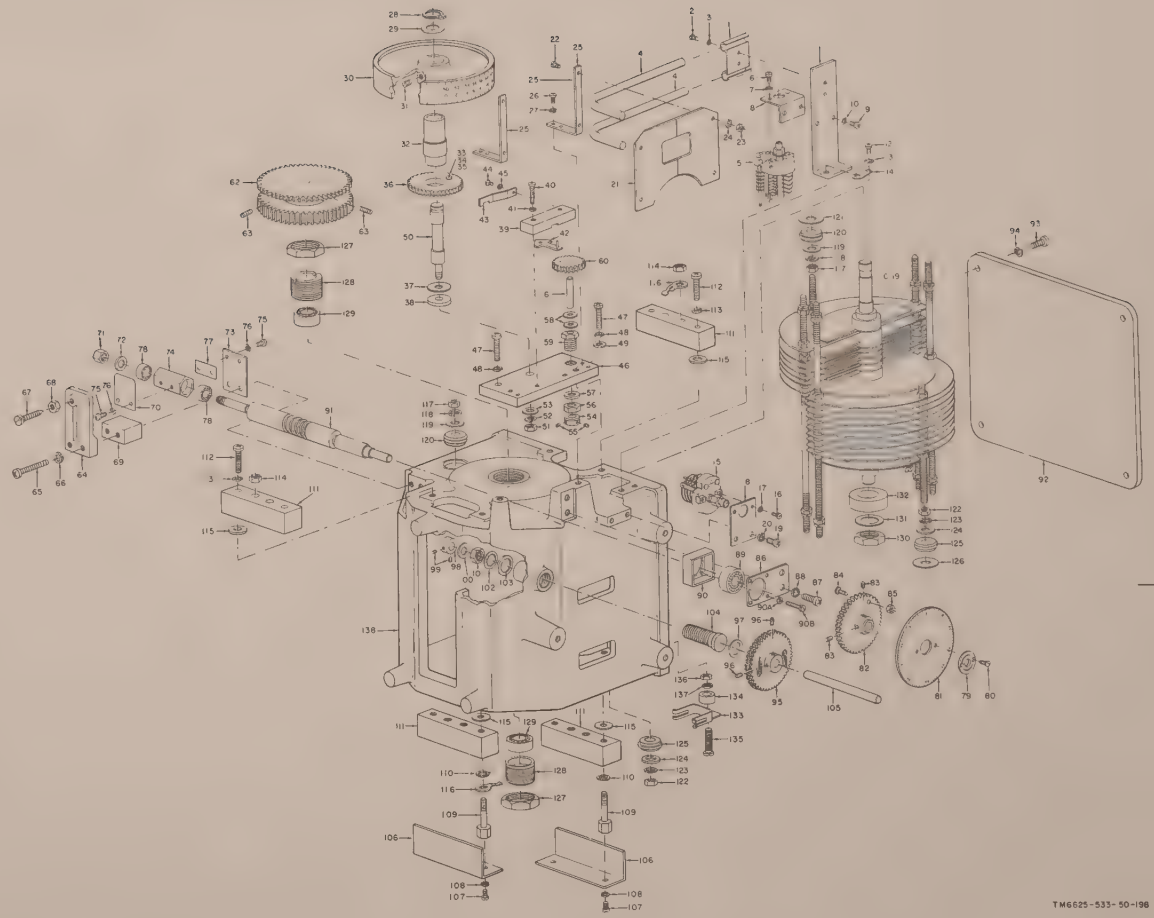


Figure 4–8. Generator, Signal SG–42/URM–18 main tuning capacitor, exploded view.

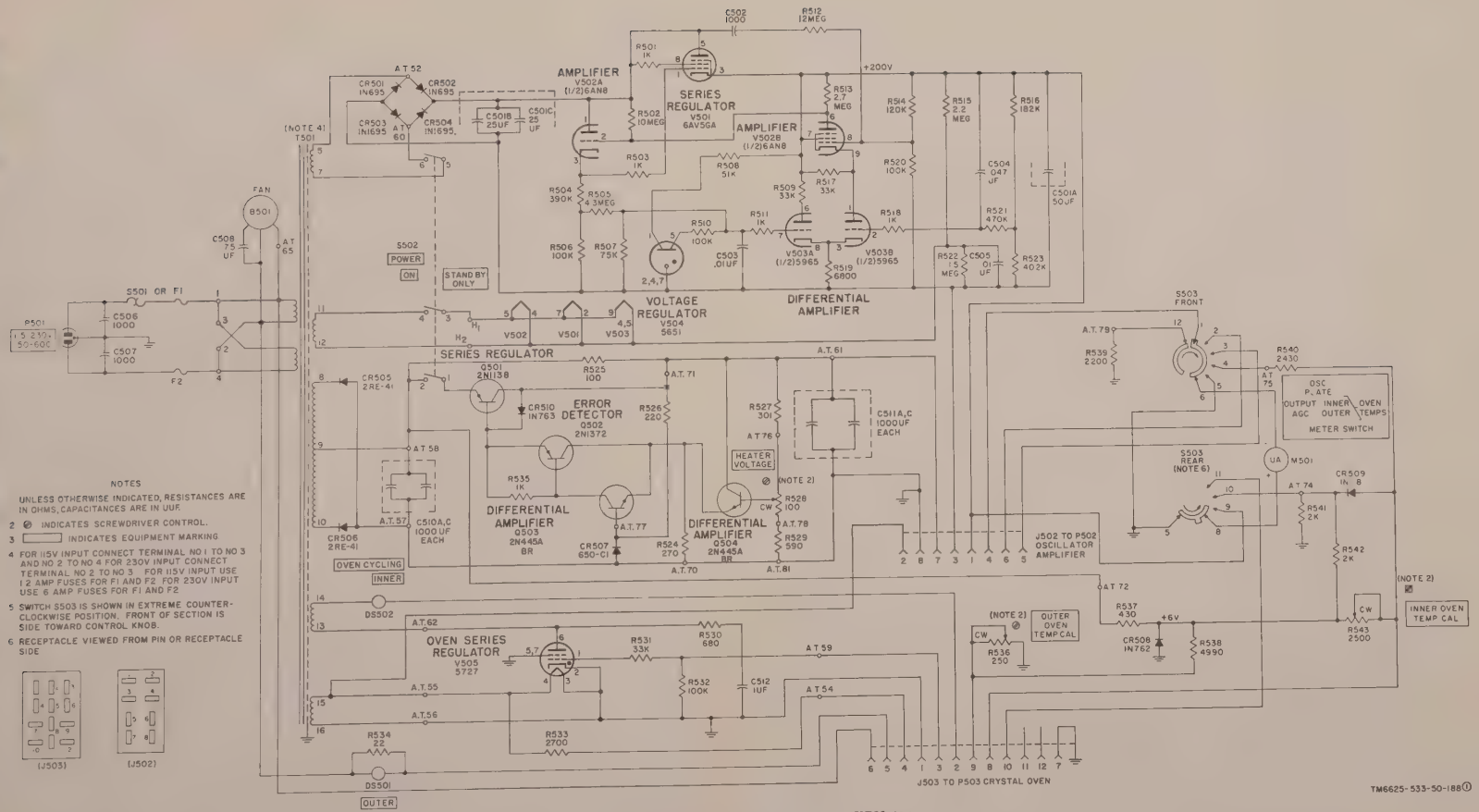

AMPLIFIER V502A (1/2)6AN8
SERIES REGULATOR V501 6AV5GA
AMPLIFIER V502B (1/2)6AN8
+200V
VOLTAGE REGULATOR V504 5651
DIFFERENTIAL AMPLIFIER
V503A (1/2)5965
V503B (1/2)5965
SERIES REGULATOR
ERROR DETECTOR Q502 2N1372
DIFFERENTIAL AMPLIFIER Q503 2N445A BR
DIFFERENTIAL AMPLIFIER Q504 2N445A BR
OVEN SERIES REGULATOR V505 5727
HEATER VOLTAGE
OVEN CYCLING
INNER
OUTER
POWER
STAND BY ONLY
FAN B501
M501
OSC PLATE OUTPUT AGC INNER OVEN TEMPS
METER SWITCH
J502 TO P502 OSCILLATOR AMPLIFIER
J503 TO P503 CRYSTAL OVEN
OUTER OVEN TEMP CAL
INNER OVEN TEMP CAL
NOTES
UNLESS OTHERWISE INDICATED, RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UUF.
2 ⊘ INDICATES SCREWDRIVER CONTROL.
3 ▭ INDICATES EQUIPMENT MARKING
4 FOR 115V INPUT CONNECT TERMINAL NO 1 TO NO 3 AND NO 2 TO NO 4 FOR 230V INPUT CONNECT TERMINAL NO 2 TO NO 3 FOR 115V INPUT USE 1.2 AMP FUSES FOR F1 AND F2 FOR 230V INPUT USE 6 AMP FUSES FOR F1 AND F2
5 SWITCH S503 IS SHOWN IN EXTREME COUNTER-CLOCKWISE POSITION. FRONT OF SECTION IS SIDE TOWARD CONTROL KNOB.
6 RECEPTACLE VIEWED FROM PIN OR RECEPTACLE SIDE
(J503)
(J502)
TM6625-533-50-188①

Figure 4-4 ①. Standard Frequency Oscillator O-1106/URM-18A, schematic diagram (part 1 of 2).

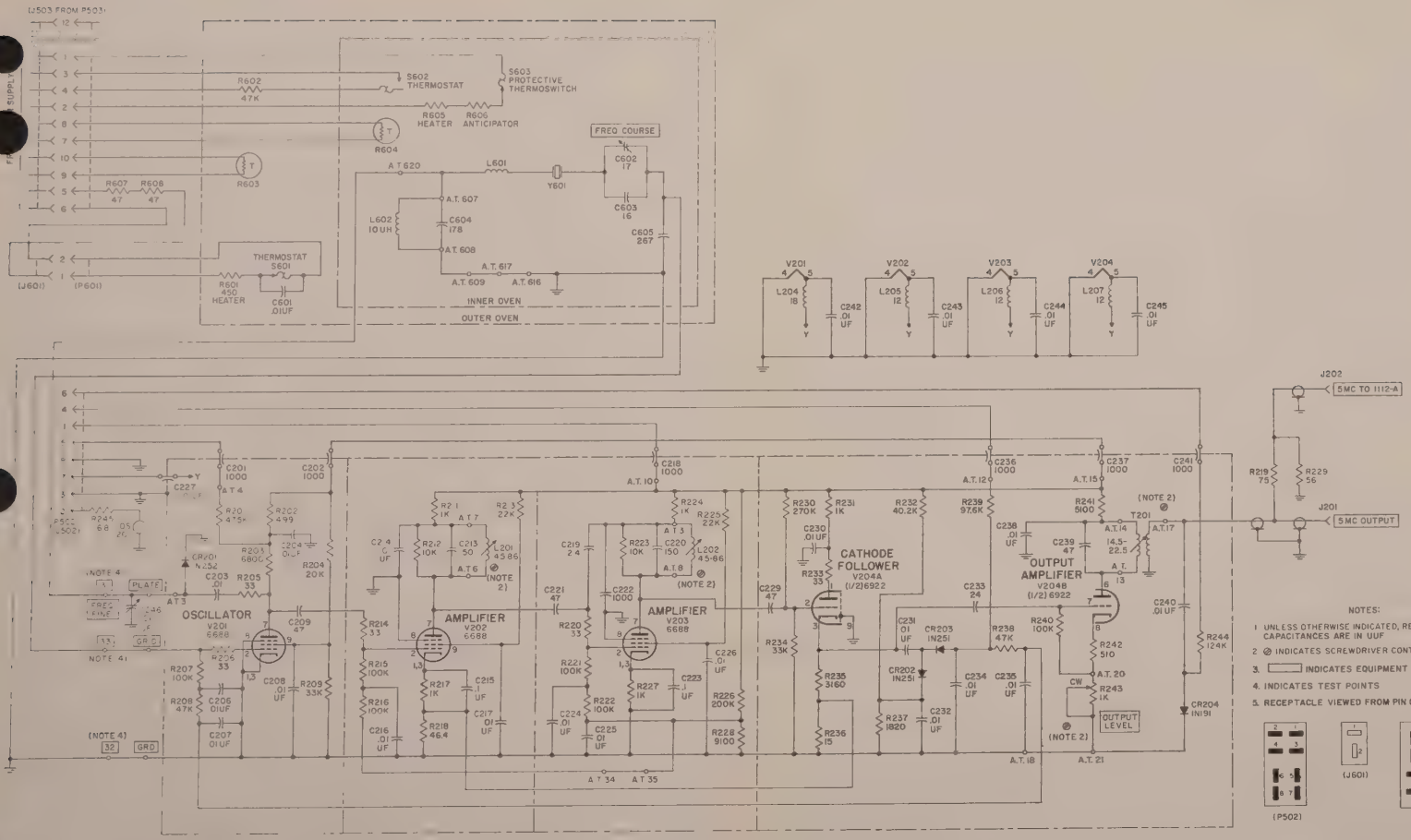


Figure 4-4 ②. Standard Frequency Oscillator O-1106/URM-18A, schematic diagram (part 2 of 2).

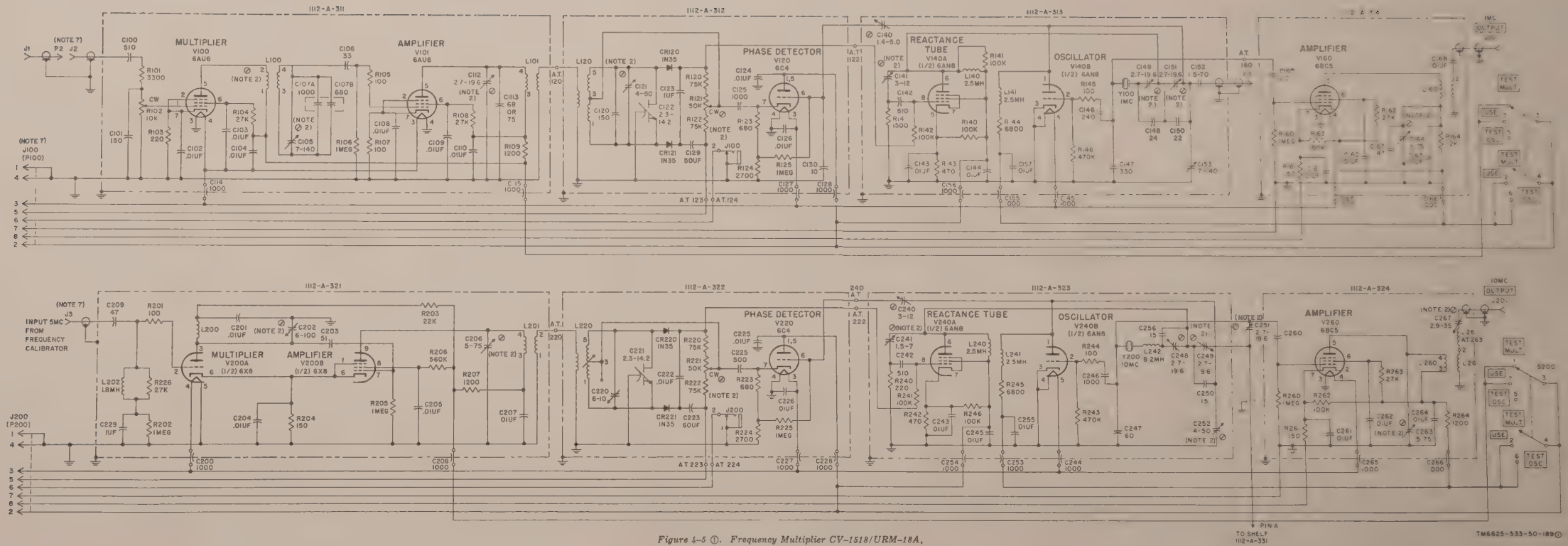
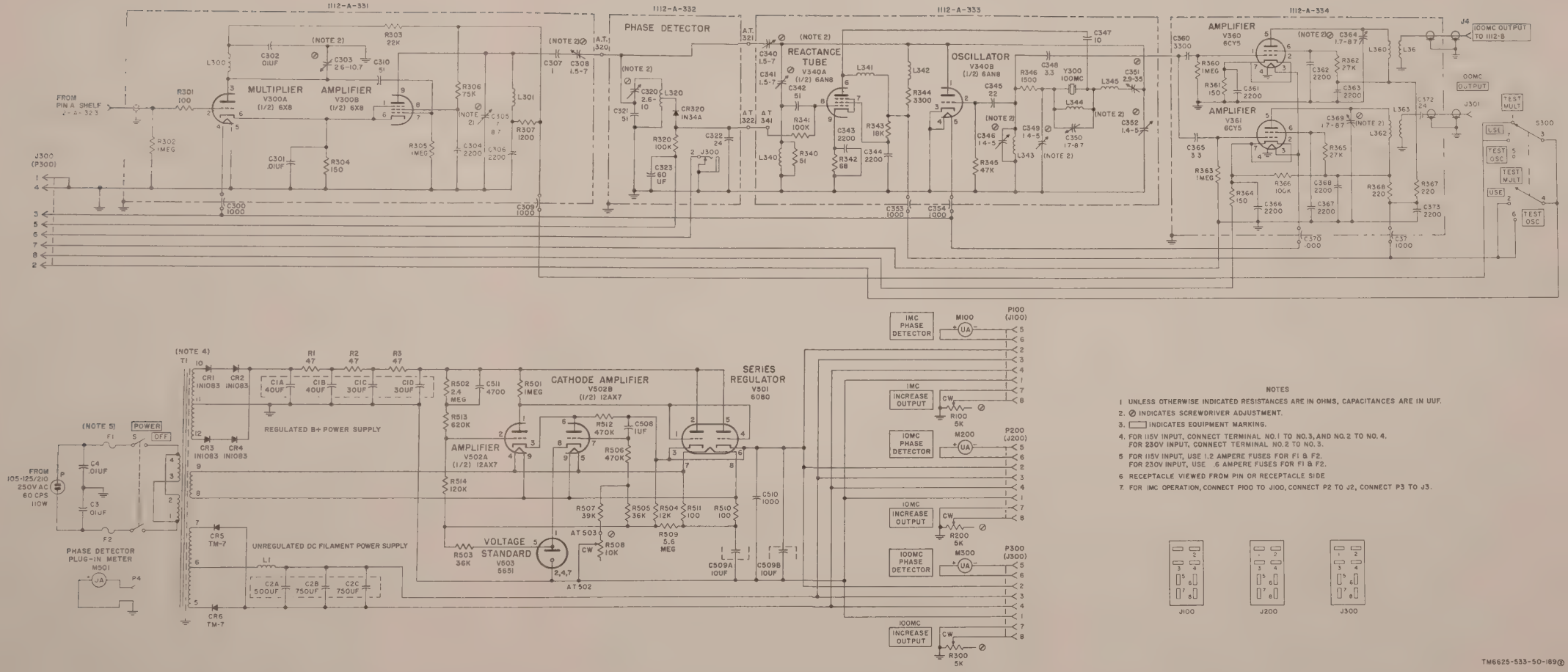


Figure 4-5 ①. Frequency Multiplier CV-1518/URM-18A, schematic diagram (part 1 of 2).



NOTES

1. UNLESS OTHERWISE INDICATED RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UUF.
2. ⊘ INDICATES SCREWDRIVER ADJUSTMENT.
3. ▭ INDICATES EQUIPMENT MARKING.
4. FOR 115V INPUT, CONNECT TERMINAL NO.1 TO NO.3, AND NO.2 TO NO.4. FOR 230V INPUT, CONNECT TERMINAL NO.2 TO NO.3.
5. FOR 115V INPUT, USE 1.2 AMPERE FUSES FOR F1 & F2. FOR 230V INPUT, USE .6 AMPERE FUSES FOR F1 & F2.
6. RECEPTACLE VIEWED FROM PIN OR RECEPTACLE SIDE
7. FOR IMC OPERATION, CONNECT P100 TO J100, CONNECT P2 TO J2, CONNECT P3 TO J3.

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Figure 4-5 ③. Frequency Multiplier CV-1518/URM-18A, schematic diagram (part 2 of 2).

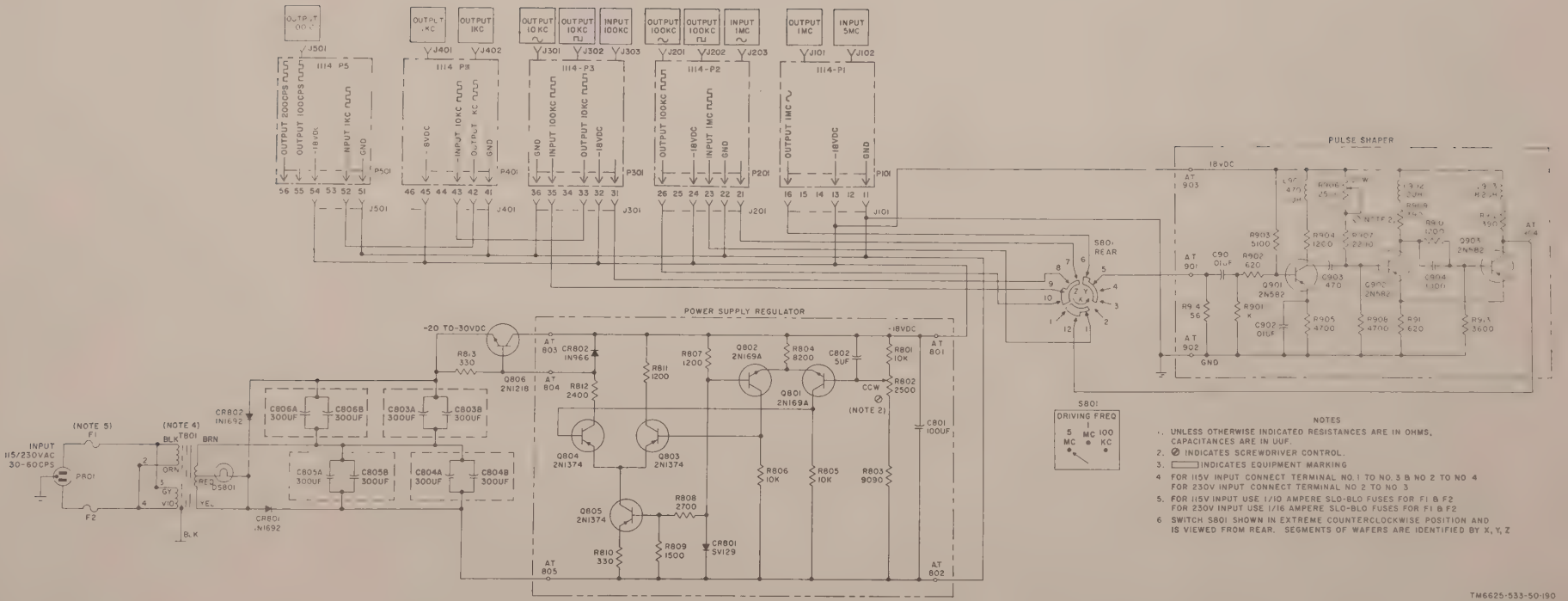


Figure 4-6. Frequency Divider DC-1517/URM-18A, schematic diagram.

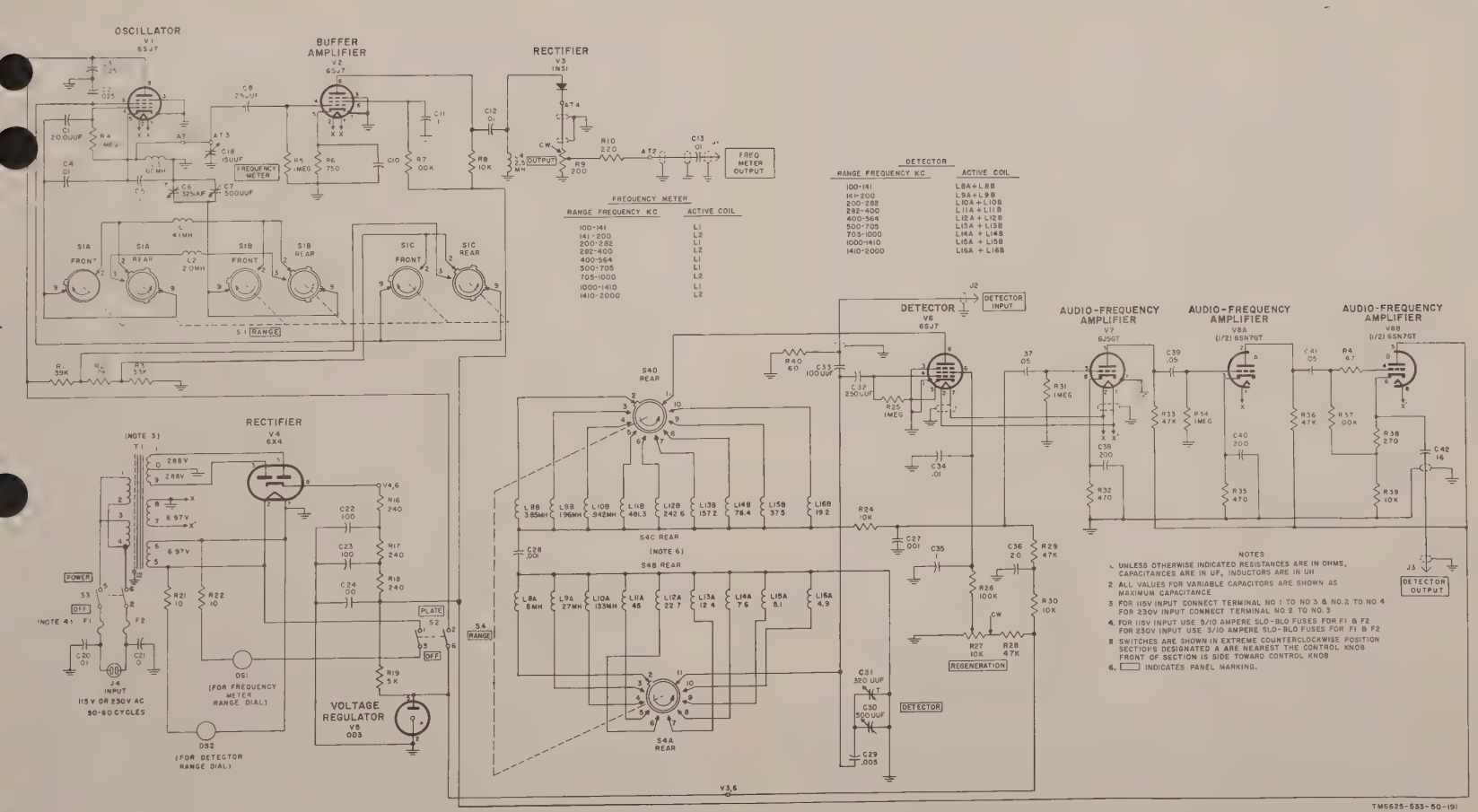


Figure 4-7. Frequency Meter FR-43A/URM-18, schematic diagram.

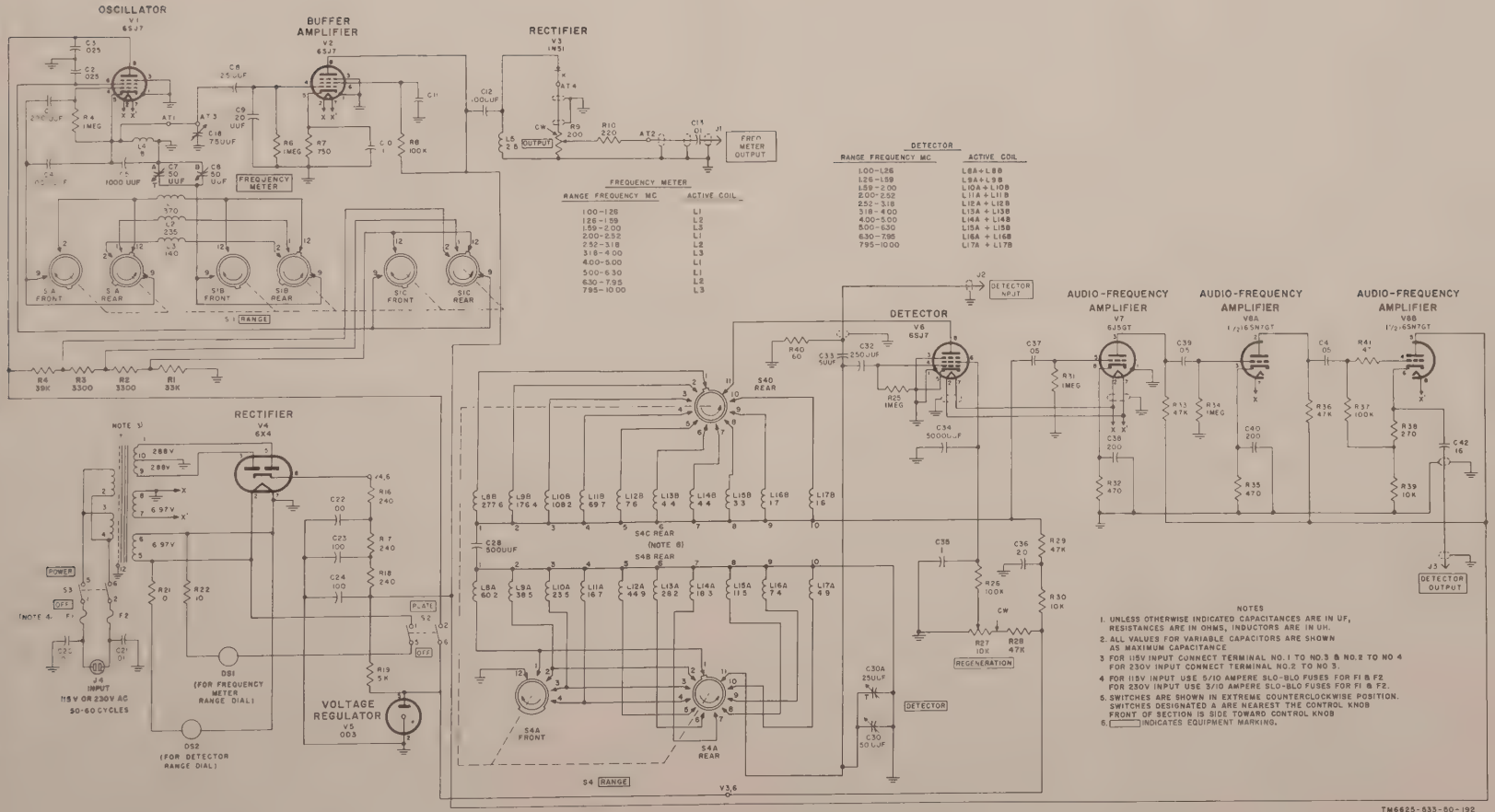


Figure 4–8. Frequency Meter FR–44/URM–18, schematic diagram.

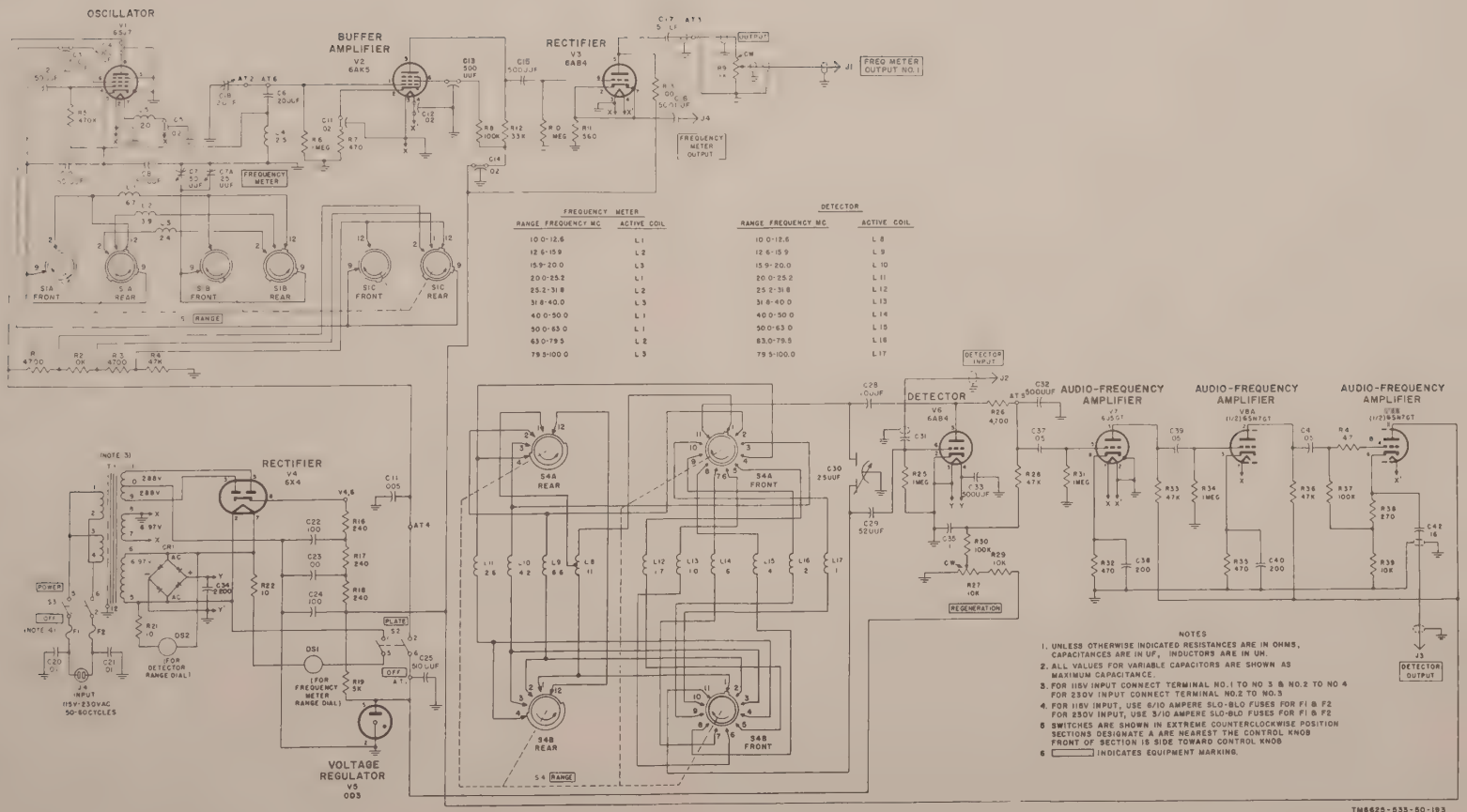
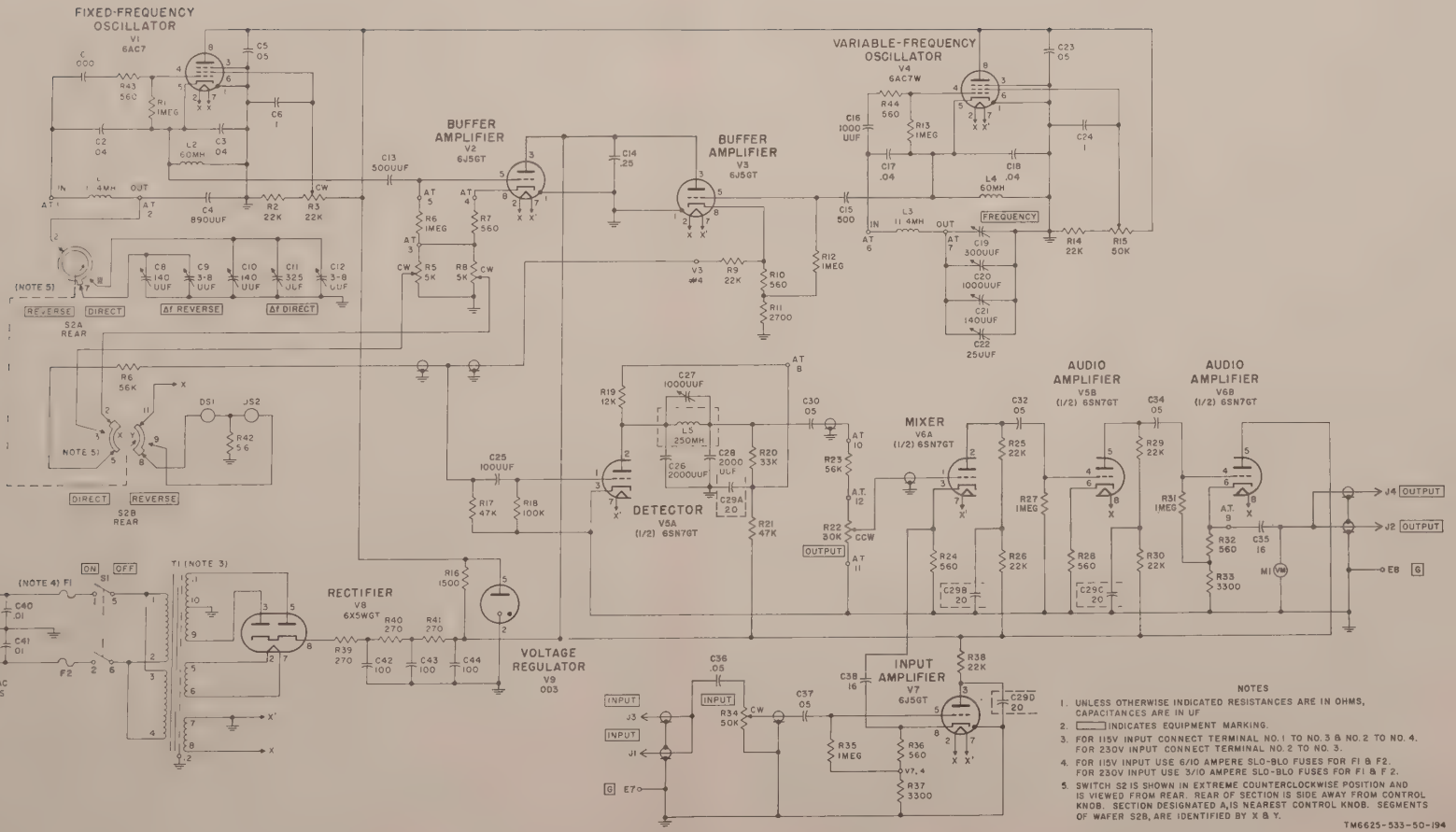


Figure 4-9. Frequency Meter FR-45A/URM-18, schematic diagram.



NOTES

1. UNLESS OTHERWISE INDICATED RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UF
2. ▭ INDICATES EQUIPMENT MARKING.
3. FOR 115V INPUT CONNECT TERMINAL NO. 1 TO NO. 3 & NO. 2 TO NO. 4. FOR 230V INPUT CONNECT TERMINAL NO. 2 TO NO. 3.
4. FOR 115V INPUT USE 6/10 AMPERE SLO-BLO FUSES FOR F1 & F2. FOR 230V INPUT USE 3/10 AMPERE SLO-BLO FUSES FOR F1 & F 2.
5. SWITCH S2 IS SHOWN IN EXTREME COUNTERCLOCKWISE POSITION AND IS VIEWED FROM REAR. REAR OF SECTION IS SIDE AWAY FROM CONTROL KNOB. SECTION DESIGNATED A, IS NEAREST CONTROL KNOB. SEGMENTS OF WAFER S2B, ARE IDENTIFIED BY X & Y.

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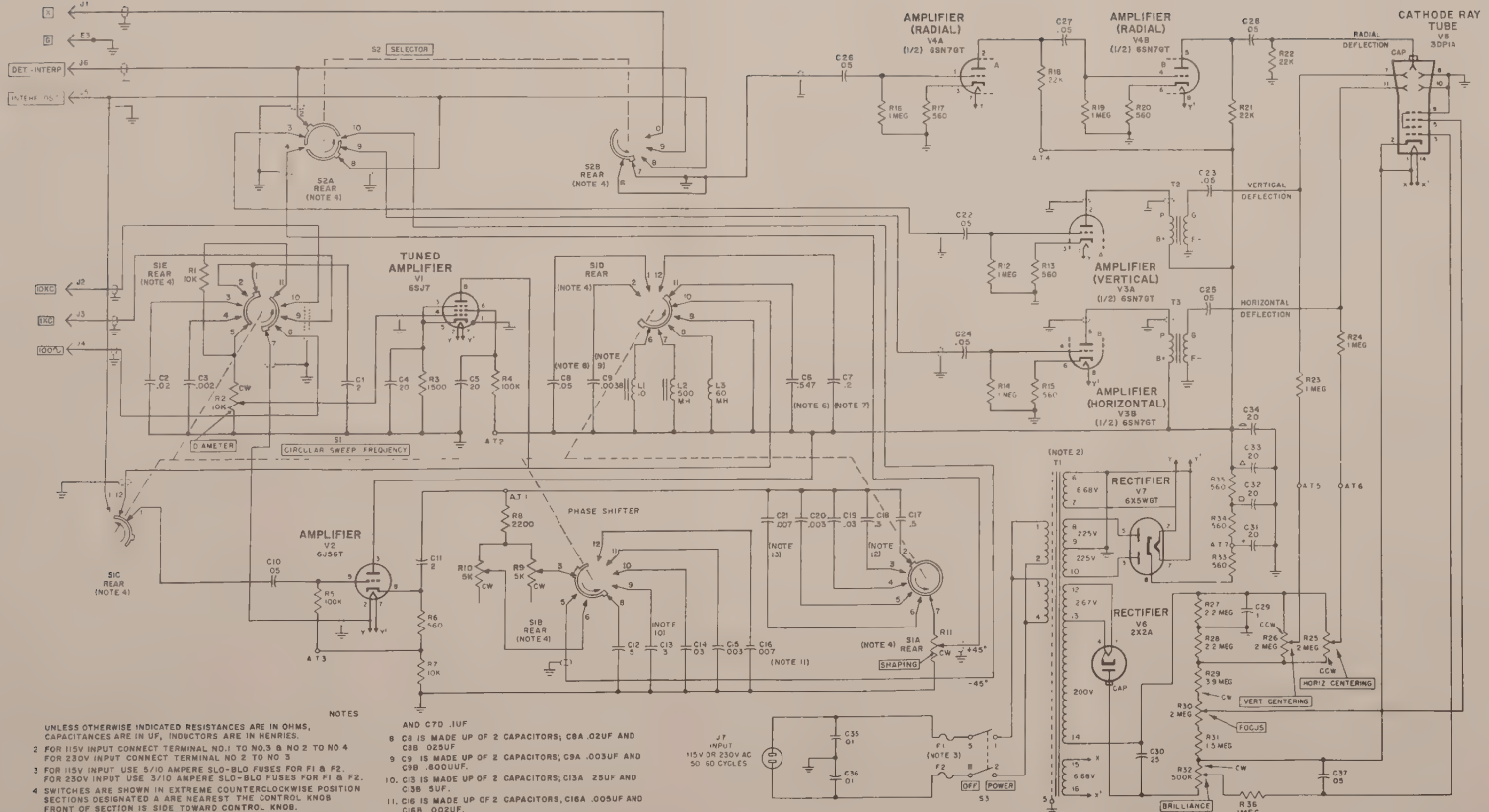
Figure 4-10. Generator, Signal SG-42/URM-18, schematic diagram.



NOTES

UNLESS OTHERWISE INDICATED RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UF, INDUCTORS ARE IN HENRIES.

2 FOR 115V INPUT CONNECT TERMINAL NO.1 TO NO.3 & NO 2 TO NO 4 FOR 230V INPUT CONNECT TERMINAL NO 2 TO NO 3

3 FOR 115V INPUT USE 5/10 AMPERE SLO-BLO FUSES FOR F1 & F2. FOR 230V INPUT USE 3/10 AMPERE SLO-BLO FUSES FOR F1 & F2.

4 SWITCHES ARE SHOWN IN EXTREME COUNTERCLOCKWISE POSITION SECTIONS DESIGNATED A ARE NEAREST THE CONTROL KNOB FRONT OF SECTION IS SIDE TOWARD CONTROL KNOB.

5 [ ] INDICATES EQUIPMENT MARKING

6 C6 IS MADE UP OF 3 CAPACITORS; C6A .03UF, C6B .25UF AND C6C .1UF.

7 C7 IS MADE UP OF 4 CAPACITORS; C7A .02UF, C7B .02UF, C7C .003UF, AND C7D .1UF

8 C8 IS MADE UP OF 2 CAPACITORS; C8A .02UF AND C8B .025UF

9 C9 IS MADE UP OF 2 CAPACITORS; C9A .003UF AND C9B .800UUF.

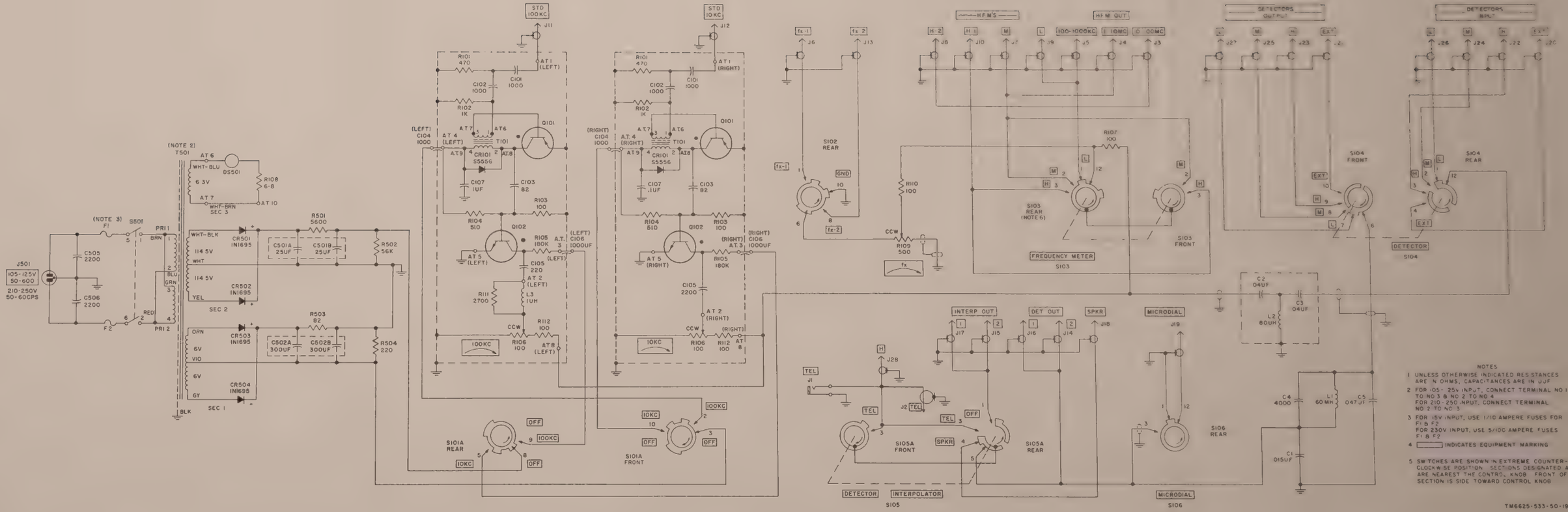
10. C13 IS MADE UP OF 2 CAPACITORS; C13A .25UF AND C13B .5UF.

11. C16 IS MADE UP OF 2 CAPACITORS, C16A .005UF AND C16B .002UF.

12. C18 IS MADE UP OF 2 CAPACITORS; C18A .25UF AND C18B .05UF

13 C21 IS MADE UP OF 2 CAPACITORS; C21A .005UF AND C21B .002UF.

Figure 4–11. Oscilloscope OS–16A/URM–18, schematic diagram.



NOTES

1. UNLESS OTHERWISE INDICATED RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UUF
2. FOR 105-125V INPUT, CONNECT TERMINAL NO 1 TO NO 3 & NO 2 TO NO 4
   FOR 210-250 INPUT, CONNECT TERMINAL NO 2 TO NO 3
3. FOR 115V INPUT, USE 1/10 AMPERE FUSES FOR F1 & F2
   FOR 230V INPUT, USE 5/100 AMPERE FUSES F1 & F2
4. ⬭ INDICATES EQUIPMENT MARKING
5. SWITCHES ARE SHOWN IN EXTREME COUNTER-CLOCKWISE POSITION. SECTIONS DESIGNATED A ARE NEAREST THE CONTROL KNOB. FRONT OF SECTION IS SIDE TOWARD CONTROL KNOB

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Figure 4-12. Panel, Control SB-105A/URM-18, schematic diagram.

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Alignment:		
Frequency divider plug-in unit:		
1114-P5	3–15	3–12
1114-P4	3–4	3–2
1114-P1	3–1	3–1
1114-P3	3–3	3–2
1114-P2	3–2	3–1
Frequency multiplier:		
1-mc to 10-mc circuit	3–20	3–13
10-mc to 100-mc circuit	3–21	3–14
Pulse shaper	3–17	3–12
Standard Frequency Oscillator O–1106/URM–18A	3–8	3–9
Checking filament and B+ circuits for shorts	2–15	2–5
Control panel:		
Functions:		
DETECTOR-INTERPOLATOR switch S105	1–102	1–100
Selector switch S104	1–101	1–97
FREQUENCY METER switch S103	1–100	1–96
Fx selector switch S102	1–96	1–94
MICRODIAL switch S106	1–103	1–100
Negative power supply	1–104	1–101
100-kc pulse generator Q102	1–98	1–96
Positive power supply	1–105	1–101
Power lamp DS501	1–106	1–102
10-kc or 100-kc blocking oscillators	1–97	1–94
10-kc pulse generator Q102	1–99	1–96
Signal substitution	2–19	2–27
CV–1518/URM–18A:		
Functions:		
Amplifiers V360 and V361 (100-mc)	1–24	1–32
Amplifier V260 (10-mc)	1–20	1–28
B+ power supply	1–25	1–32
B+ power supply regulators V501, V502, and V503	1–26	1–34
Multiplier V300 (10- to 100-mc)	1–21	1–29
Multiplier V200 (5- to 10-mc)	1–17	1–24
Oscillator and reactance tube V240 (10-mc)	1–19	1–25
Oscillator and reactance tube V340 (100-mc)	1–23	1–30
Phase detector CR320 (100-mc)	1–22	1–30
Phase detector V220 (10-mc)	1–18	1–25
Unregulated dc filament power supply	1–27	1–36

	Paragraph	Page
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Frequency Divider CV–1517/URM–18A	2–11	2–4
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FR–44/URM–18	2–7	2–3
FR–45A/URM–18	2–8	2–3
Frequency Multiplier CV–1518/URM–18A	2–13	2–5
Generator, Signal SG–42/URM–18	2–9	2–4
Oscilloscope OS–16A/URM–18	2–10	2–4
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Standard Frequency Oscillator O–1106/URM–18A	2–12	2–4
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Applicable references	4–2	4–1
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Frequency Divider CV–1517/URM–18A	4–6	4–3
Frequency Meters:		
FR–43A/URM–18	4–7	4–4
FR–44/URM–18	4–8	4–4
FR–45A/URM–18	4–9	4–4
Frequency Multiplier CV–1518/URM–18A	4–5	4–2
Generator, Signal SG–42/URM–18	4–10	4–5
Oscilloscope OS–16A/URM–18	4–11	4–6
Panel, Control SB–105A/URM–18	4–12	4–7
Standard Frequency Oscillator O–1106/URM–18A	4–4	4–1
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1114-P3	3–13	3–11
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Signal substitution	2–27	2–41

	Paragraph	Page
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Block diagram discussion Schematic, fig. 4–6	1–28	1–37
Dc resistance, transformers and coils	2–11	2–24
Tests	4–6	4–3
Frequency meter:		
Functions:		
Audiofrequency amplifiers V7, V8A, and V8B	1–73	1–75
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Detector RANGE switch S4 and detector V6	1–72	1–74
Power supply section	1–74	1–75
RANGE switch S1 and oscillator V1	1–69	1–72
Rectifier V3	1–71	1–74
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Signal substitution	2–25	2–38
Tests	4–8	4–4
FR–43A/URM–18:		
Dc resistances, transformers and coils	2–6	2–3
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Tests	4–7	4–4
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Buffer amplifier V2	1–70	1–73
Detector RANGE switch S4 and detector V6	1–72	1–74
Frequency meter RANGE switch S1 and oscillator V1	1–69	1–72
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Phase shifter	1–89	1–87
Power supply section	1–94	1–92
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Negative power supply	1–104	1–101
100-kc pulse generator Q102	1–98	1–96
Positive power supply	1–105	1–101
Power lamp DS501	1–106	1–102
Switches:		
DETECTOR-INTERPOLATOR, S105	1–102	1–100
Detector, S106	1–101	1–97
FREQUENCY METER	1–100	1–96
Fx selector, S102	1–96	1–94
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Output amplifier V204B	1–10	1–13
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Amplifier gain control (DIAMETER) and tuned amplifier V1	1–87	1–85
Amplifier V2	1–88	1–87
Cathode-ray tube V5	1–93	1–92
Phase shifter	1–89	1–87
Power supply section	1–94	1–92
Radial amplier V4A and V4B	1–92	1–92
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Trigger generator Q401	1–49	1–56
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Emitter follower Q307	1–46	1–54
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Monostable multibrators Q302 and Q303	1–43	1–50
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	Paragraph	Page
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Rf filter circuit	1–81	1–82
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For explanation of abbreviations used, see AR 320–50.

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